QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

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ECONOMIC GEOLOGY OF THE CITY OF BRISBANE

by

BEVERLEY R. HOUSTON, B.Sc. (Hons), Special Geologist

BRISBANE
By Authority: S. G. REID, Government Printer
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FOREWORD

This account of the mineral resources of the City of Brisbane may be regarded as supplementing G.S.Q. Publications 323 (Map) and 324 (Geology of Brisbane). Actually the investigation of the City's mineral resources, initiated at the request of the City Council, was the *raison d'être* of the mapping programme.

Since the discovery of coal at Moggill by John Williams in 1848 numerous industrial rock and mineral prospects have been inspected and reported on but no systematic account of the City's mineral resources has been published.

Essential to the evaluation of the clay and sand deposits were the drilling of more than 1,700 closely spaced shallow auger holes by the Department's Boring Branch, and firing and other tests of a very large number of samples by the Government Chemical Laboratory.

Fifteen officers of the Geological Survey were at one time or another engaged in the investigation which led to the preparation of this report.

A. K. DENMEAD,
Chief Government Geologist.

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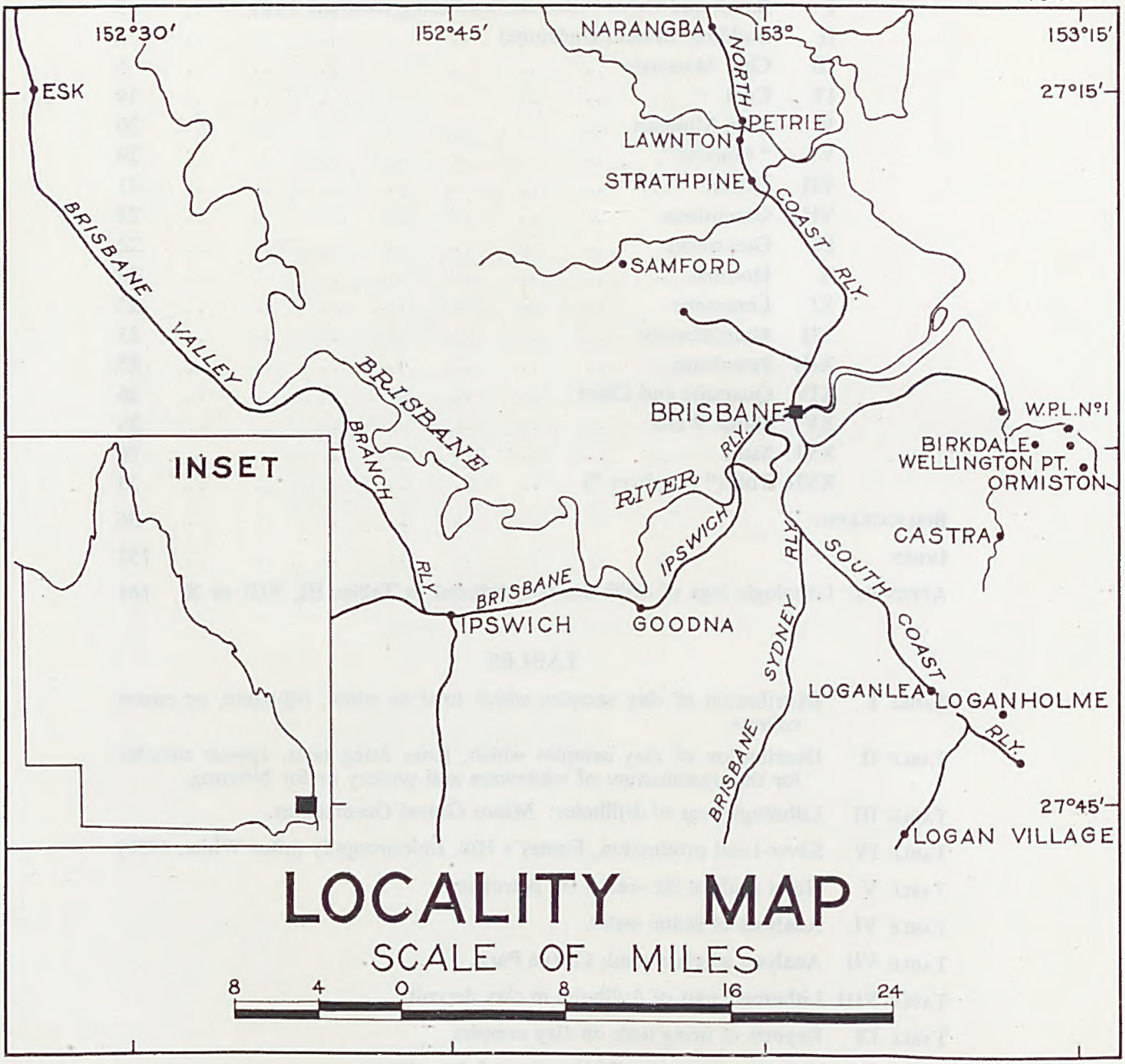

LOCALITY MAP

SCALE OF MILES

8 4 0 8 16 24

ECONOMIC GEOLOGY OF THE CITY OF BRISBANE

by BEVERLEY R. HOUSTON, Special Geologist

ABSTRACT

A brief account of the past and current exploitation of industrial rock and mineral deposits in the City of Brisbane is presented together with the results of a recent (1959-1965) geological investigation of the mineral resources of the City. The logs of about 1,700 auger holes, reports of firing tests on clay samples and the results of mechanical analyses of sand samples are tabulated. Commercial deposits of rocks and minerals occurring in the undeveloped areas of the City are indicated for the guidance of future prospectors and town planners.

This paper follows on from Geological Survey of Queensland Publication 324 (Geology of the City of Brisbane) and is the first systematic account of the industrial rock and mineral deposits of the City to be published.

The deposits with the greatest potential are of clay materials (particularly for the ceramic industry), rock suitable for the production of "crushed rock" and sand for a wide variety of uses. Almost all of the geological units recognised in the City contain economic deposits of one or more of these materials.

INTRODUCTION

In area, the City of Brisbane is the second largest city in the world being, officially, 376·36 square miles. Compared with the area, the population is small (649,500 at the end of 1963) and thus there are considerable areas of undeveloped land in the outer suburbs which are ideal for industrial development.

HISTORICAL

Coal was first discovered within the present day limits of the City of Brisbane by John Williams who opened a pit at Moggill in 1848. This was the first recorded geological discovery of economic importance in the City. It was followed by the publication of a number of brief reports by Samuel Stutchbury, A. C. Gregory, R. L. Jack, W. E. Cameron, E. O. Marks, L. C. Ball and H. C. Richards on the occurrence, search for and exploitation of coal and building stones. From the nineteen-twenties to nineteen-forties L. C. Ball investigated and reported on various geological deposits of economic materials including silver-lead, gold, oil shale and coal.

In addition to this work, officers of the Geological Survey of Queensland have inspected numerous prospects in the City and prepared reports on them but no systematic account of the economic geology of the City of Brisbane has been published to date.

RECENT WORK

In the outer suburbs of the City of Brisbane geological mapping, with an economic bias, was carried out by the following officers of the Geological Survey of Queensland between 1958 and 1961:—P. E. Bock, D. J. Casey, F. Cox, L. G. Cuttler, P. L. Ellis, V. R. Forbes, B. R. Houston, J. W. Laycock, I. G. Sanker, C. H. Shipway, the late N. A. H. Simmonds, R. M. Tucker and K. W. Wolff. Supplementary mapping was carried out by B. A. Coxhead, B. R. Houston and J. D. Sawers between 1963 and 1965.

The aim of the investigation was to produce

(i) a geological map of the City of Brisbane*
(ii) a report on the geology of the City†
(iii) an account of the economic geology of the City (this report).

In this report an attempt has been made to describe briefly the past and present working of industrial rock and mineral deposits and to indicate suitable localities for future exploitation. Accompanying the report is a 1:31, 680 (40 chains to an inch) geological map of the area overprinted with all available information concerning the location and extent of the economic deposits.

METHOD

Field mapping was concentrated in the outer, undeveloped areas of the City and the information concerning deposits in the built-up areas was obtained from all available sources including published and unpublished geological and historical papers and personal recollections of senior staff members of the Geological Survey and the University of Queensland.

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* Geological Map of the City of Brisbane compiled by Beverley R. Houston (G.S.Q. Publication 323).

† Geology of the City of Brisbane by R. M. Tucker and Beverley R. Houston (G.S.Q. Publication 324).

The investigation was directed primarily at locating and evaluating clay and sand deposits which generally occur in areas of negligible outcrop. More than 1,700 shallow auger holes were drilled in 1960-61 and 1963-65 with a tractor-mounted Proline auger using 3 ft x 4 in. rods. These holes, the numbers of which are prefixed by the letters "BMP", are plotted on the accompanying map sheets or on Figures 2 or 3. A mixed sample from each 3 ft interval was obtained from the auger for examination and a representative set was kept and stored in the Geological Survey's Core Library at Redbank. These samples are available for examination on application.

Some of the stratigraphic diamond drillholes sunk by the Mines Department in the northern and eastern suburbs (Houston, 1967) produced valuable information on the basalt, tuff and clay deposits.

A representative set of samples of clay materials was submitted to the Government Chemical Laboratory for firing tests. These tests, results of which are tabulated in the report, involved the making by hand of a series of small tablets, about 12cm x 2cm x 1cm, from each sample after mixing with water. The tablets were then tested for plasticity and allowed to dry at air temperature (2-3 days) before the shrinkage was calculated. The dry tablets were fired in an electric muffle furnace under neutral or slightly oxidising conditions at temperatures of 900° C, 1,000° C, 1,100° C, 1,200° C and 1,300° C, the rise in temperature being restricted to 1° per minute for the first 500° C. To test for efflorescence one end of a fired tablet is immersed in ½ in. of water for 24 hours. Under these conditions the water is drawn upwards by capillary action carrying with it any soluble salts present. The salts are deposited at the top of the wet part of the tablet.

The fired tablets can be examined at the Head Office of the Geological Survey on application.

The drilling and firing test results were used together to select areas which could be classed as clay deposits. The boundaries of these deposits were drawn by joining with straight lines the outermost holes of a cluster which intersected ceramic clay materials. The reserves in each deposit were estimated from the average thickness of workable clay materials in the relevant auger holes and the area enclosed by the somewhat arbitrary boundaries of the deposit, without reference to the topography. As most of the deposits are in areas of negligible relief and few of the auger holes reached the base of the clay, the estimation of the reserves is believed to be generally conservative.

The sand deposits were located by auger drilling and sampled in cased holes with an improvised bailer. Mechanical analyses of the samples taken were carried out in the Engineering Geology Section of the Geological Survey. The appraisal of the sand deposits is based on the results of the drilling and of the mechanical analyses.

The base maps used for the field work were the Lands Department's Brisbane and Suburbs 20 chain sheets (1–8) and the relevant 20 chain Series sheets. Aerial photographs (1:25,000) were available for part of the area in the later stages of the programme. The published map is on a special base drawn by J. A. Wright of the Mines Department Drafting Section. All grid references, unless otherwise stated, refer to an arbitrary grid drawn on this map.

Acknowledgements

I am indebted to all whose contributions have made the writing of this paper possible particularly Messrs. J. W. Laycock, J. D. Sawers and B. A. Coxhead (Geological Survey), who played a major part in the supervision of the drilling and Mr. W. Whitaker (University of Queensland), who spent one of his long vacations assembling data on the clay deposits. I am deeply grateful to Messrs. H. G. S. Cribb (Assistant Chief Government Geologist) and T. H. Connah (Senior Geologist), who assisted with the historical side of the investigation, Mr. J. A. Wright (Mines Department), who assisted with the presentation, Messrs. C. H. Couper (Government Chemical Laboratory) and G. M. Smith (Geological Survey), who tested the clays and sands and to all those who assisted with the proof-reading.

The co-operation of the various companies working clay, sand and gravel deposits in the City who supplied information concerning their operations is acknowledged with thanks. I am particularly grateful to Messrs. T. Payne (Brickworks Ltd.), R. Brittain (Ralph Brittain & Co. Pty. Ltd.), A. F. Gunthorpe and W. H. Humphries (Brittains Bricks & Pipes Pty. Ltd.), H. Wightman (Oxley Brickworks Pty. Ltd.), J. Wade (P.G.H. Industries (Qld) Pty. Ltd.), A. Hall (Virginia Pipes Pty. Ltd.) and C. W. Johannsen (Wunderlich Ltd.) who took so much trouble to show me over their plants and make me conversant with aspects of the heavy clay industry in Brisbane in 1965.

I offer my deepest thanks to Messrs. A. K. Denmead (Chief Government Geologist) and J. H. Brooks (Supervising Geologist, Economic Geology) without whose encouragement and guidance this report would not have been completed.

INDUSTRIAL ROCK AND MINERAL DEPOSITS

Industrial rocks and minerals are located in the following geological units occurring in the City of Brisbane and described by Tucker and Houston (in press):—

?Precambrian	Bunya Phyllite
?Silurian	Neranleigh-Fernvale "Group"
?Permian	Brookfield Volcanics and Jolly's Lookout andesites
?Lower Triassic	Enoggera Granite and Indooroopilly Intrusives
?Middle Triassic	Sugars Basalt, Colleges Conglomerate and Tivoli-Cooneana Formations undifferentiated
	Brisbane Tuff, Tingalpa and Moorooka Formations
Tertiary	Darra, Corinda, Sunnybank and Petrie Formations and Tertiary basalt undifferentiated
Cainozoic undifferentiated	Witty Gravel
Quaternary	alluvium

The deposits with the greatest potential are of clay (particularly for the ceramic industry), rock suitable for the production of "crushed rock" and sand for a wide variety of uses. Of less importance are deposits of coal, building stones and, possibly, brine. Deposits of minor importance are those of limestone, ores, oil shale, gas and gem minerals.

I. BASALT AND OTHER VOLCANICS
(excluding Brisbane Tuff)

Basalt

Occurrences of basalt and basaltic rocks are fairly widespread in the City of Brisbane but little of the material is suitable for commercial utilisation due to the depth of weathering.

Deposit Ba 1 (190155; Map Sheet 2)

This "basalt" deposit is the most promising in the City. It lies to the south of Mt. Crosby Road, between Hawkesbury Road and the Brisbane River, at Moggill.

The volcanic pile (Sugars Basalt) is rather heterogeneous with some 300 ft of interbedded spilitic lavas and pyroclastics overlying an undetermined thickness of unaltered basalt (Houston, 1965). In the diamond drillhole Ipswich N.S. 256 (190147) about 80 ft of decomposed shale, sandstone and tuff overburden was intersected but to the north of this point where the "basalt" crops out the overburden is highly decomposed "basalt" ranging in thickness from 0 to 50 ft. It is probable that use could be made of this decomposed material if quarrying were commenced.

The entire deposit is currently owned by the Brisbane City Council, Australasian Oil Exploration Ltd. and Wm. Collin & Sons Pty. Ltd. but is not being worked.

An abandoned quarry at 181155 is owned by the Brisbane City Council and may be re-opened in the future.

Deposit Ba 2 (226167; Map Sheet 2)

This deposit has not been worked nor investigated in any detail but there appears to be a considerable thickness of "basalt", similar to that in Deposit Ba 1, in the area of outcrop. Fresh rock occurs at the surface, in part.

Deposit Ba 3 (555095; Map Sheet 1)

More than 100 ft (probably 130 to 140 ft) of predominantly fresh Tertiary basalt and olivine basalt underlie 2 to 3 ft of soil and about 10 ft of decomposed basalt in this area. The major part of the surface of the deposit is occupied by the Archerfield Aerodrome and an old R.A.A.F. base. South of Mortimer Road, suburban division is rapidly expanding.

The Brisbane City Council formerly worked the abandoned quarry at 569089; the base of the basalt is believed to have been reached before abandonment but the depth of the quarry, which is now almost full of water, is unknown.

Deposit Ba 4 (356830; Map Sheet 3)

Tertiary basalt and olivine basalt of variable quality occur near Capalaba on the western side of Tingalpa Creek. In diamond drillhole Brisbane N.S. 17 (357831) basalt was intersected from the surface to 85 ft but the top 40 ft were decomposed. In the bed of Tingalpa Creek at 365835 fresh basalt crops out. The area is one of slight relief and south of Capalaba development is limited to a few small farms.

Deposit Ba 5 (339963; Map Sheet 3)

Fine-grained, fairly fresh basalt was formerly quarried at Reformatory Hill, Lytton. Limited reserves remain but further working is unlikely as an oil refinery has recently been constructed nearby.

Minor Occurrences

Tertiary basalt is extensive in the *Runcorn-Eight Mile Plains* area, between *Manly* and *Tingalpa* and in the *Bald Hills* area but the depth of weathering is much too great for economic exploitation.

Andesite

Deposit Vo 1 (155282; Map Sheet 4)

An overall thickness of about 80 ft of flow andesite occurs at the top of the Brookfield Volcanics. Deposition was on a highly irregular surface but quarry sites suitable for working this deposit could be found. The approaches to the area are very steep and, at present, the andesite is accessible only on foot. This problem should not prove insurmountable if the material is required.

Weathered Rhyolitic Pyroclastics

Deposit Vo 2 (155290; Map Sheet 4)

The weathered pyroclastics which occur in the lower part of the Brookfield Volcanics appear similar to material used in Colorado (U.S.A.) as pozzolan

(Ellis, 1961). Practical tests would be necessary to show whether the Brookfield material could be used for this purpose.

The area is undeveloped but the provision of access, although difficult, would not be impossible.

?Silurian Basic Volcanics

A belt of recrystallised basic volcanics (Tucker, 1967), up to a quarter of a mile wide, follows the strike of the Neranleigh-Fernvale "Group" from Mt. Ommaney in the south (361160; Map Sheet 2) to Mt. Nebo Road in the north (070157; Map Sheet 4). In general the depth of weathering is considerable but several deposits which are believed to be suitable for exploitation have been located.

Deposit Vo 3 (363160; Map Sheet 2)

Recrystallised basic volcanics, with minor associated quartzite, crop out on the southern and eastern slopes of Mt. Ommaney. The area is undeveloped but readily accessible and ideal quarry sites are available.

Mt. Ommaney Quarry (359173; Map Sheet 2)

Recrystallised basic volcanics, greywacke and quartzite were formerly obtained from this quarry on the south bank of the Brisbane River. It has been abandoned for some years and has reverted to scrub but there appears to be sufficient material present to warrant re-opening.

Other Occurrences

Outcrops of recrystallised basic volcanics occurring at the following localities are of possible economic interest (Tucker, pers. comm.):—

Pullenvale Road (310225; Map Sheet 4)
Mt. Elphinstone (285260; Map Sheet 4)
Brookfield Road (263296; Map Sheet 4)
Mt. Nebo Road (268427 and 149462; Map Sheet 4)

II. BUILDING STONES (SANDSTONE)

Much of the stone used in erecting the prominent buildings of the City of Brisbane in the second half of the nineteenth century and the early twentieth century was obtained from local quarries in the Enoggera Granite, Brisbane Tuff, Tivoli-Cooneana Formations undifferentiated and Tingalpa Formation. The rocks used were adamellite ("granite" p. 20), tuff ("porphyry"; p. 35) and sandstone. The stones and their utilisation have been described by Richards (1918) and Wolff (1957). Hornfelsed phyllite (p. 23) has potential value as building stone.

The sandstones worked were the "Goodna Sandstone" (Gailes-Goodna area), "Moggill Sandstone" (Moggill area) and "Breakfast Creek Sandstone" (Albion). The first two mentioned were from the Tivoli-Cooneana Formations undifferentiated and the last from the Tingalpa Formation.

"Goodna Sandstone" (Map Sheet 2)

This material was worked in three quarries, none of which have been located:—

Jeays' Quarry

Jeays' Quarry, which was worked chiefly between 1860 and 1870, was the largest of these and produced the best stone. It is known to have been in the Goodna Mental Hospital Reserve (327030).

Woogaroo Quarry

The Woogaroo Quarry of Smith and Rees was situated on the river bank close to Jeays' Quarry. It was abandoned after being flooded twice towards the end of the nineteenth century.

Geary's Quarry

Geary's Quarry at Goodna produced stone, which weathered very badly, for building St. Stephen's Roman Catholic Church in Elizabeth Street, City. The quarry has not been located and may even have been beyond the City limits.

"Moggill Sandstone" (Map Sheet 2)

"Moggill Sandstone" was obtained from four quarries, only one of which has been located:—

Lyon's Quarry

Lyon's Quarry produced a brown, poorly-cemented sandstone of which very little use was made. The quarry has not been located but is presumed to have been in the vicinity of Lyon's Shaft (coal) which was sunk in portion 117, parish of Moggill. The portion is centred about 250096.

Sandstone was obtained from two quarries in the contiguous portions 110 and 111, parish of Moggill, between Hawkesbury Road and the Brisbane River. Of these, only the more southerly has been located (182099). Denmead (1955) reported that "for any purpose where a light-coloured sandstone is required these quarries are believed to be capable of supplying an abundance of high-grade stones in reasonably large blocks".

The fourth quarry was reported by Rands (1890) to have been in the high bank of the river on Fraser's selection, portion 135, parish of Moggill which is centred about 244072.

"Breakfast Creek Sandstone" (Map Sheet 3)

The "Breakfast Creek Sandstone" was worked from the eighteen-sixties to the eighteen-eighties in two quarries at Albion which replaced Jeays' Quarry in importance:—

Petrie's Quarry

Petrie's Quarry (651430) was a fairly small quarry which bottomed in shale at about 35 ft and which was subsequently worked to a minor extent for use in the manufacture of pipes (p. 5).

Bryden's Quarry

Bryden's Quarry (645431) later became known as Campbell's Quarry when the sediments underlying the sandstone were worked by James Campbell & Sons Pty. Ltd. for ceramic use (see below).

Both quarries have been abandoned for some years and have now been levelled and utilised for building purposes.

III. CLAY MATERIALS

In this paper the term "clay material" is used in a general sense to include clay (*sensu stricto*) and other materials such as decomposed shale, mudstone, siltstone, phyllite, etc., which, when crushed, behave in a similar manner to clay and can be utilised for the same industrial purposes. The term "ceramic" is used to refer to the manufacture of all types of fired products including pottery, bricks, etc.

Clay materials are the most widespread of the industrial rocks and minerals occurring in the City of Brisbane and have been obtained in quantity from the ?Silurian Neranleigh-Fernvale "Group", the Triassic Brisbane Tuff and Tingalpa and Moorooka Formations, the Tertiary Oxley Group and Petrie Formation and from Quarternary alluvium. As the clay materials from the Palaeozoics commonly contain abundant free quartz attention has, of recent years, been focused on the Triassic and Cainozoic clays of which more than adequate supplies for the forseeable future have been located in Brisbane and at Strathpine (Laycock, in preparation).

Claypits, too numerous to mention individually, have been worked in Brisbane over the past 70 years or more for a wide variety of purposes, particularly ceramic manufacture. The major pits, other than those which are currently worked, are located at:—

Colmslie (712385; Map Sheet 3)

In this quarry Quaternary alluvial clays were worked by James Hardie & Co. for the manufacture of terracotta roofing tiles before their works was closed down about 1959. In the period 1951-59 32,256 tons of clay were won from the pit.

Coorparoo (705235; Map Sheet 3)

Two small pits near the present day Cavendish Road Reservoir were worked until 1958 as a source of pottery clay for Chas. A. Stone & Sons' (later Australian Ceramics Pty. Ltd.) Bristol Pottery at Coorparoo. In the period 1951-58, 2,975 tons of clay, valued at £4,600, were won from these pits.

Albion (645431; Map Sheet 3)

Sediments of the Tingalpa Formation and Brisbane Tuff were worked here by James Campbell & Sons Pty. Ltd. for the manufacture of pottery and heavy clay products. No production figures are available.

Albion (651430; Map Sheet 3)

Between 1954 and 1957 about 76 tons of Tingalpa Formation shale were won from this quarry for use in the Virginia pipeworks.

Ferny Grove (375499; Map Sheet 4)

Alluvial clays with a high free quartz content were worked in this pit by Wunderlich Ltd. for the manufacture of terracotta roofing tiles from 1928 to 1963. The clays were derived from the Bunya Phyllite and abandonment was necessary because of an increasing abundance of randomly distributed quartz in the clay. In the period 1951-62, 56,839 tons of clay were won.

Runcorn (723012; Map Sheet 1)

Of the smaller pits, probably the best known is the Persse Road Quarry where limited reserves of white clay still exist. It was formerly a source of pottery clay for James Campbell & Sons Pty. Ltd.

Sunnybank (Map Sheet 1)

An indefinitely located pit at about 668007 was worked from 1939 to 1956 for pottery clay for James Campbell & Sons Pty. Ltd. In the period 1944-56 about 1,123 tons were won.

Current Operations

Five brickworks, two pipeworks and one tileworks are currently (September, 1965) producing in the City of Brisbane. All of these plants, except for one brickworks, were inspected during 1965 and their activities are described on pp. 6-10.

Hosking and Hueber (1949) reported most unfavourably on the efficiency in the heavy clay products industry in Queensland at that time. It has been gratifying to note during the present survey the changes which have taken place in the industry in Brisbane in the last 16 years.

Pit-working is generally mechanised with front-end loaders and bulldozers widely used but in some of the pits there is still little evidence of planned working of tested sections. The clay is generally trucked to the plants from nearby pits but some is carried considerable distances.

Proportioning of the mixes is generally by mechanical shovel or similar method but automatic feeders have been installed in some plants.

There has been a general change from the use of stiff-plastic machines to semi-dry presses; three manual machines are still in use.

Systems of conveyer belts have been established but mechanical handling of the ware could, in general, be increased considerably.

Beehive, rectangular downdraft, downdraft arch, open square and updraft kilns and one patent Hoffman kiln are variously used and many have been or are being converted from coal-fire to oil-burning. This conversion has greatly increased efficiency by reducing fuel costs and firing time and by permitting an even, controlled temperature throughout the kilns.

In general, use of Tertiary and Quaternary clay materials involves problems of variable shrinkage and resultant cracking. These problems are overcome by mixing different raw materials, adding grog and/or drying in open sheds or in drying chambers. The Triassic clay materials can generally pass direct from the pit through the mill and into the kilns. Many of these, however, contain highly carbonaceous or coaly bands and when such material is fired under normal conditions, iron blisters are commonly produced. Efflorescence, caused by the presence of soluble vanadium salts, is commonly seen on bricks which have been stacked in the open. No solution to this problem has, as yet, been found.

After reading Hosking and Hueber's paper, one is left with the impression that the quality of the bricks produced in the City of Brisbane has improved vastly since 1949 although under-burning to produce light colours is still practised to some extent.

The present output of bricks appears to be only slightly less than the demand. There is a lag of up to a few months between ordering and supplying face bricks of special colours and of 6 to 7 weeks for standard face bricks. Common bricks can be supplied upon demand.

BRICKS

Brickworks Ltd.

Brickworks Ltd., a Sydney company, commenced operations at Gardner Road, Rochedale, in 1958 after purchasing a small brickworks which had been opened by Queensland Industries Pty. Ltd. in 1953.

LEASES: M.L.s 289-296, 334 and 811 (Map Sheet 1).

RAW MATERIALS: The raw materials currently used in the works include Triassic dark grey carbonaceous shale, white shale and white shale mottled with very fine-grained, red, micaceous sandstone from the pit at 823134 (Map Sheet 1). As the shrinkage of these materials is fairly constant, admixture of grog has not been found necessary.

In the period 1958-64 some 185,000 tons of clay materials, valued at £65,700, were won by blasting and dozing and trucked to storage sheds for use in the mill.

PROCESS: The colours produced in firing depend wholly on the proportions of the different clay materials in the raw mix. The required amounts of the various shales are mechanically fed on to an endless belt and conveyed to the crushing plant which consists of a double impact roller and two grinding pans. The crushed mix passes a $\frac{3}{16}$ in. flat vibrating screen before conveyance to hoppers above the presses.

Eight semi-dry presses, using a mix with about 14% moisture, are currently in use. The stacked green bricks from the machines are carried direct to the kilns and set with fork-lifts.

Firing is at 1,060°C to 1,120°C in nine down-draft arch kilns which are currently being converted from coal-burning to oil-burning. Total kiln capacity is about 1,030,000 articles and firing time is 4–5 days. A tenth kiln, with a capacity of 135,000, is at present being built.

CAPACITY AND PRODUCTS: The plant capacity is about 500,000 articles per week including standard building bricks and special moulded bricks. The colours include shades of cream, buff, red and pink.

DISTRIBUTION: The major distribution is to the Brisbane metropolitan area and the Gold Coast but a certain number of bricks are sent to the near North Coast, Toowoomba, Western Queensland and to New Guinea.

RESERVES: Reserves have not been fully proved but appear sufficient for the forseeable future.

Ralph Brittain & Co. Pty. Ltd.

This company was founded at Douglas Street, Darra, by Mr. Ralph Brittain and two associates in 1950 and is the smallest brickworks in the City at present.

LEASES: M.L.s 952 and 955 (Map Sheet 2).

RAW MATERIALS: Light to dark grey, fossiliferous, semi-plastic Tertiary clay, with yellow, greenish, purplish and chocolate bands, is worked in the pit at 469101 (Map Sheet 2). Light ironstaining is present on the joint surfaces.

The clay is rippped from the face and mixed on the floor of the pit by bulldozer before trucking direct to the plant for use in the semi-dry press. If extruded bricks are to be made, water and grog (fired rejects) are mixed with the clay in the pit before it is trucked to the plant.

An estimated 30,182 tons of clay, valued at £5,297, were won from the pit in the period 1960-64.

PROCESS: The clay, fresh from the pit, is fed through a variable speed box-feeder to two sets of rollers and is thence conveyed to a patent crusher consisting of a cylinder containing blades rotating at 1,000 r.p.m. The crushed mix passes a $\frac{5}{16}$ in. steeply included screen to a Foster semi-dry press or to an extruder.

The green bricks are manually stacked in an open shed to dry for at least two weeks before hand-setting in the kilns. Firing is in three coal- and wood-burning updraft kilns for 7 days at an unmeasured temperature. The total kiln capacity is 180,000 articles. A new oil-burning downdraft arch kiln, with a capacity of 74,000 bricks, is in process of erection. Firing in this kiln will be at about 1,000°C and the time should be reduced to 5 days.

CAPACITY AND PRODUCTS: The plant has an estimated annual capacity of 2 million standard building bricks and step bullnose bricks which are golden or red in colour.

RESERVES: Drilling has shown that workable clay persists to at least 60 ft in the present pit and beyond its limits.

Brittains Brickworks Pty. Ltd.

Brittains Bricks & Pipes Pty. Ltd. (Harcourt Road, Darra) was founded at Ebbw Vale about 1895 by Mr. William Brittain, an English migrant. He moved to Darra about 1900 to make bricks and about 1910 a second plant was set up to manufacture pipes. The parent company, which is operated by the third generation of the family, supplies the raw materials to two subsidiary companies.

In the periods 1952-56 and 1959-64 some 722,290 tons of clay materials valued at £123,839, were processed in the two plants.

LEASES: M.L.s 251, 252, 255, 256, 279 and 940 (Map Sheet 2); M.L.'s 939 and 942 (Strathpine; Figure 1).

RAW MATERIALS: The raw materials used in the brickworks include blue plastic clay and light brown shale of Tertiary age from the pit at 435103 (Map Sheet 2), light grey slightly ironstained decomposed Tertiary shale from 434094 (Map Sheet 2), soft brown Tertiary shale from 439101 (Map Sheet 2) and grey plastic Triassic clay from 447112 (Map Sheet 2). About 1,700 tons are currently processed each week.

The raw materials are won by shale-planers or back hoes and trucked to the plant where the required proportions of the different materials are tipped into a box-feeder for conveyance to large storage bins after primary crushing in break-up rollers. It is intended to instal a second box-feeder so that mix proportions can be controlled mechanically instead of by front-end loader. Sand grog is used only for admixture with particularly fatty clays which cannot be removed from the presses cleanly.

PROCESS: From the storage bins the raw mix is conveyed to two crushing pans and thence to large hoppers above the presses.

Seven semi-dry press machines (using a mix with a moisture content of 16–18%), two stiff-plastic machines (using a mix with about 20% moisture) and one extruder are in use. In the extruder, the pugged clay is de-aired in a vacuum before extrusion on to a belt where it is automatically wire-cut.

The green bricks are manually stacked in well-ventilated sheds to dry for at least six weeks to reduce the moisture content of the semi-dry press articles to 7–8%.

The dried bricks are hand-set in nine downdraft arch kilns, which have a total capacity of 585,000, and one continuous fire downdraft kiln which has 20 chambers and a total capacity of 370,000 bricks. The kilns are being converted from coal-burning to oil-burning. Firing is for 4 days at 1,050°C to 1,150°C.

CAPACITY AND PRODUCTS: The present capacity of about 500,000 articles per week should soon be increased to 600,000. The products are standard building bricks and special moulded bricks and the colours —shades of buff, cream, red, brown, black and pink— are dependent on variations in the raw mix.

DISTRIBUTION: The major distribution is in the Brisbane metropolitan area with a percentage sent to the Gold Coast and Toowoomba areas.

RESERVES: The company is shortly to undertake systematic testing of its clay reserves.

Oxley Brickworks Pty. Ltd.

Oxley Brickworks (Ipswich Road, Darra) was founded during the Second World War and commenced full-scale production in 1946.

LEASE: M.L. 277 (Map Sheet 2).

RAW MATERIALS: All raw materials used in the works are obtained from the nearby pit at 454094 (Map Sheet 2) where interbedded dark grey (carbonaceous), greenish-grey and red and green mottled clays and decomposed sandstone of Tertiary age are exposed in the face. Ironstone bands, up to four inches thick, occur near the top of the section and are removed by hand if possible. As the shrinkage of the clay materials varies considerably from bed to bed, complete mixing of the different types is essential. This is achieved by ripping a complete section from top to bottom of the face and, after drying in the open for a few hours, mixing the ripped material by front-end loader before trucking to storage sheds.

In the period 1952-64, 216,710 tons of clay materials, valued at £71,919, were won from the pit.

PROCESS: From the storage sheds the mix is conveyed to two 9-ft grinding pans from which the crushed mix, with a moisture content of about 10%, passes through $\frac{3}{8}$-in. inclined screens to four semi-dry presses.

The green bricks are manually stacked in well-ventilated sheds where they remain for at least a month to reduce the moisture content to about 6% before being hand-set in the kilns.

Firing is in six downdraft arch and four open coal-burning kilns which have a total capacity of approximately 600,000 articles. The firing time is 7 days and the temperatures reached are 950°C and 1,150°C at the bottoms and tops of the kilns respectively.

CAPACITY AND PRODUCTS: The plant has an annual capacity of 6 million articles including standard building bricks, special moulded bricks and 9-in. paving tiles. The colours produced are light buff, reddish-brown and medium to dark brown and these are wholly dependent on the positions of the articles in the kilns.

DISTRIBUTION: Distribution is chiefly in the Brisbane metropolitan area with small quantities sent to the Gold Coast.

RESERVES: The clay materials in the pit persist to 55 ft below the present floor.

P.G.H. Industries (Qld) Pty. Ltd.

P.G.H. Industries currently operates one brickworks in the City of Brisbane, at Yarradale Street, Newmarket. The plant was constructed in 1912 or earlier and was purchased by the Brisbane Brick and Builder's Supply Co. Ltd. (now a subsidiary of P.G.H. Industries (Qld) Pty. Ltd.) in the nineteen-twenties.

A second plant, at Wynnum Road, Murarrie, was purchased from a Mr. Shannon by Brisbane Clay Products Pty. Ltd. (now also a subsidiary of P.G.H. Industries (Qld) Pty. Ltd.) about 1935 and was closed down three years ago. It is believed that this plant was opened by a Mr. Kelly about the eighteen-nineties.

The Newmarket brickworks was not visited during the present survey but the following information was obtained from the company's Research and Development Officer.

Leases: M.L.s 258 and 260 (Map Sheet 3); M.L.s 957-960 (Strathpine; Figure 1); M.L. 223 (Dinmore, about 20 miles south-west of Brisbane). M.L.s 273-276 were held at Strathpine between 1950 and 1959. In the period 1951-64 production of clay materials for the company's Newmarket and Murarrie plants was as follows:—

M.L. 258 (1951-64): 201,437 tons valued at £71,449;

M.L. 260 (1955-63): 54,508 tons valued at £20,584;

M.L.s 273-276 (1951-60): 291,385 tons valued at £176,298;

M.L. 223 (1951-June 1964): 23,300 tons.

No production figures for the Dinmore lease after 1955 are available.

Raw Materials: The raw materials currently used in the Newmarket plant are dark grey and brown clay, formed by the weathering of Triassic shale, from Murarrie (808332; Map Sheet 3); hard blue-black Triassic shale from Dinmore and decomposed ?Silurian sheared sediments from Newmarket (547440; Map Sheet 3).

Process: The various raw materials are trucked to the mill where different mixes are made up with a front-end loader and fed into grinding pans. The crushed mixes are elevated to lofts where they are manually shovelled into hoppers above the presses.

The ware is made on three semi-dry presses, two stiff-plastic presses and an extrusion machine for which the wet mix is de-aired in a vacuum. The green articles are set on pallets and stored in open sheds for about three weeks to dry.

Some of the ware is hand-set and fired for 8 to 10 days in six coal-burning downdraft arch kilns which have a total capacity of 360,000 articles. The remainder, with the moisture content reduced, is dried and oil-fired in a patent Hoffman kiln which has a capacity of 180,000 articles per week. Setting is partly by fork-lift and partly by hand. In this oval kiln the bricks remain stationary and the fire is moved.

Capacity and Products: The plant has a total capacity of about 300,000 articles per week including white semi-dry press standard bricks, cream stiff-plastic standard bricks and cream extruded agricultural pipes, screen wall blocks, lumber blocks and stahlton blocks.

Distribution: Distribution of these products is chiefly in the Brisbane metropolitan area.

Reserves: The company has a well-equipped laboratory and research staff at Strathpine for the control of its Newmarket and Strathpine plants and for testing reserves, etc. Reserves on the current leases have been fully tested and prospecting for new deposits is in hand.

PIPES

Brittains Pipeworks Pty. Ltd. (p. 7).

Raw Materials: The raw material currently used in this works is a 4:6:4 mix of decomposed buff Triassic shale from 439112 (Map Sheet 2), decomposed ?Silurian recrystallised basic volcanics from 327147 (Map Sheet 2) and grey, carbonaceous to coaly Triassic shale from 445120 (Map Sheet 2). The materials are won by back-hoe and trucked to the plant where they are kept in separate storage bins. About 920 tons are currently processed each month.

Process: In the primary crushing, each of the constituents is handled separately. From the bins they are loaded into a box-feeder for passage through two sets of differential speed rollers and conveyance to a set of hoppers. A dust extractor has been installed over the rollers.

From these hoppers the required proportions of the different shales and the phyllite, together with about 10% grog (fired rejects), are mechanically fed on to an endless belt for mixing, secondary crushing and pugging. The dry material is mixed in a barrel mixer and transferred to a double shaft mixer where water is added. The moist mix is further crushed in a set of high speed rollers and mixed, with the addition of more water, in a second double shaft mixer, from which it passes through a pugging machine for extrusion on to an endless belt where it is automatically cut into workable lengths by a hydraulically operated wire-cutter. The moisture content of the extruded mix is varied according to requirements for different products.

The cut lengths are manually transferred to different parts of the works as required.

An extrusion machine is used for making 9-in. paving tiles and screen wall blocks which are dried in open sheds for about three weeks. The straight pipes are pressed on two automatic extrusion machines, loaded on "trees" and placed in drying rooms for 24 hours. A temperature of 120°C is maintained in the rooms by small oil-burning jets. Large articles are made in moulds and fittings are finished by hand.

The tiles and wall blocks are hand-set in two coal-burning downdraft arch kilns, with a total capacity of about 16,000 articles, and salt-fired at about 1,100°C for 85 hours. The pipes are hand-set on cement dust in eight oil-burning downdraft arch kilns, each with a capacity of 2½ to 3 thousand articles, and salt-fired at about 1,050°C for 40 hours.

The pipes are tested for size, as tolerances are very small, and for strength under water pressure.

CAPACITY AND PRODUCTS: The plant has a capacity of about 10,000 articles per week including all types of pipes and fittings and glazed 9-in. paving tiles and screen wall blocks in shades of red.

DISTRIBUTION: The fired products are distributed all over Queensland but the bulk of the pipes are used by the Brisbane City Council.

Virginia Pipes Pty. Ltd.

Virginia Pipes Pty. Ltd. was founded more than 70 years ago and was formerly known as Enoggera & Virginia Bricks & Pipes Pty. Ltd. Originally, bricks only were produced in two plants at Enoggera and Virginia. In the nineteen-twenties the Virginia plant at Jefferis Street was gradually converted from brick manufacture to pipes. The Enoggera plant has not been located and its history is unknown.

The company was recently taken over by Queensland United Foods Ltd. and the Virginia pipeworks is now worked in conjunction with pipeworks at Molendinar and Mackay and a brickworks at Townsville.

LEASES: M.L. 280 (Map Sheet 1); M.L. 325 (Map Sheet 5); M.L. 284 (Strathpine; Figure 1).

RAW MATERIALS: Three types of raw material, which are won and carted under contract, are used in the plant. Greenish-grey plastic Tertiary clay from Strathpine, decomposed buff Triassic fossiliferous shale from Belmont (760195; Map Sheet 1) and blue-grey to brown sandy alluvial clay from Virginia (670553; Map Sheet 5) are mixed in the proportions of 3:3:1. The Virginia clay is added to regulate the shrinkage of the Strathpine clay; grog (fired rejects) is also added to the mix when it is to be used for making large pipes.

In the period 1953-64 production of raw materials was as follows:—

M.L. 280: 26,208 tons of clay valued at £19,007;

M.L. 325: 15,394 tons of shale valued at £4,619;

M.L. 284: 36,359 tons of clay valued at £22,198.

PROCESS: The raw materials are stored in sheds to dry before being manually shovelled into a grinding pan in the desired proportions. The crushed mix passes a ⅛-in. flat rotary screen for conveyance to bins above the various presses. From these bins the mix passes through double shaft mixers, where water is added, to the machines.

Three extrusion machines are in use. A patent manual press makes fittings and a Foster manual machine makes large pipes. The wet mix passes through a chopping system for de-airing before extrusion through the third machine, a Hampton automatic pipe press, which makes straight pipes. Fittings are hand-finished.

An underground system of conveyer belts carries the waste pug back to the crusher.

The green pipes are carried from the machines on pallets, some of which are wheeled directly into an oil-fired drying chamber where the pipes are dried at 200 to 210°C for 28 hours. The remainder are stacked on racks in open sheds where they dry for 4 to 5 days.

The pipes are salt-fired for 32 to 34 hours in 10 kilns which have an average capacity of 32 tons of ware. A temperature of 1,050°C is attained at the bottoms of the kilns. Eight of the kilns are of the rectangular downdraft type and two are downdraft beehives. Six of the kilns, including one beehive, have been converted from coal-fire to oil-burning.

The fired ware is tested for size and resistance to water pressure before distribution.

Polyurethane joints are moulded on to a percentage of the pipes.

CAPACITY AND PRODUCTS: The plant has an annual capacity of between ½ and ¾ million articles including all types of pipes and fittings from 4 to 15 in. The coal-fired pipes are a much darker brown in colour than those which are oil-fired.

DISTRIBUTION: Distribution is chiefly in the Brisbane metropolitan area with a percentage sent to the near North Coast, Western Queensland and New Guinea.

RESERVES: Some 50 to 60 years' supply of raw materials have been proved in the company's leases.

TERRACOTTA ROOFING TILES

Wunderlich Ltd.

Wunderlich Ltd. was founded in Sydney in 1887 by the brothers Ernest and Alfred Wunderlich to produce stamped metalwork.

In 1928 an established tileworks at Ferny Grove was purchased and terracotta roofing tiles were made there until the plant was closed in 1963. The clay used (from the pit at 375499; Map Sheet 4) was alluvial and contained abundant, randomly distributed free quartz which eventually forced the cessation of operations.

In 1951 the company opened a second tileworks, at Frederick Street, Northgate, and this is now the only factory producing terracotta tiles in Queensland.

LEASES: M.L.s 262 and 263 (Map Sheets 3 and 5) and M.L. 932 (Map Sheet 1).

RAW MATERIALS: The raw materials used in the plant are interbedded grey-brown, yellow, red, black, red and grey, and yellow and grey Quaternary alluvial clay from a pit at Northgate (719536; Map Sheet 3), white Triassic shale from a pit at Rochedale (820158; Map Sheet 1) and grog, prepared by crushing fired rejects to pass an 80-mesh screen.

Montmorillonite and illite are significant components of the Northgate clay which contains a high percentage of colloidal material and is thus problematic to dry. The shale and grog are added to reduce and standardise the shrinkage and prevent cracking during firing. The clay is won with a non-selective bucket excavator and thus the quantities of shale and grog added (10 to 20%) depend on the thicknesses of the different beds in the pit at the time; the percentage of shale added also varies with the colour to be produced and the product to be made.

A small quantity of clay can be stored under cover but the use of stored Northgate clay is avoided where possible as its firing properties change considerably after storage.

In the period 1951-64 production was as follows:—

M.L.s 262 and 263: 101,457 tons of clay valued at £70,369;

M.L. 932: 4,415 tons of shale valued at £5,650.

PROCESS: The required proportions of the clay, shale and grog are loaded onto an apron feed for carriage to the primary crusher, two sets of differential speed rollers. The crushed material is mixed in a double shaft mixer before crushing in two more sets of rollers. The crushed mix is conveyed to a pug machine where water is added, if necessary. The pug is extruded on to an endless belt where it is automatically cut into 16½-in. lengths which are manually transferred to the presses.

Bongioanni tile presses, with plaster moulds, are in use together with presses for making air vents, and ridge and barge tiles. Paving tiles are prepared on a separate extrusion line.

The green tiles are conveyed, via a patent machine for making the tying holes, to a point from which they are carried into drying chambers where they are mechanically dried by waste heat from cooling kilns until the moisture content is less than 6%. Drying is necessarily slow as the colloidal clay causes skin hardening under fast drying conditions.

The dried ware is fired in eight forced-draft rectangular downdraft coal-burning kilns.

PRODUCTS: The articles made are standard glazed roofing tiles, ridge and barge tiles, air vents, paving tiles and brickettes. Colouring depends partly on the mix, partly on position in the kilns and partly on the glaze. Flat, semi-gloss and gloss finishes are obtained from different parts of salt-fired kilns.

Tiles in shades of red, orange and cream are produced by salt firing different raw mixes in different parts of the kiln. Brown and black tiles are made by mixing manganese dioxide with the salt used in glazing. Muntz tiles are glazed in colours ranging from yellow to pink by adding metallic zinc to the salt. Engobe tiles are produced by spraying dried green tiles with a mixture of ball clays, bentonite, kaolinite and oxides of chromium, cobalt, manganese or iron. On firing, pure white to pale grey to charcoal to honey shades to greens and blues are produced depending on the oxides used.

DISTRIBUTION: The major distribution is to the Brisbane Metropolitan area but tiles are sent to most coastal areas of Queensland.

RESERVES: Testing of reserves has indicated the presence of sufficient clay for use in the plant in the next 30-40 years.

OTHER PRODUCTS

Apart from their use in the manufacture of heavy clay products, clay materials from deposits in the City of Brisbane are used to a limited extent in the manufacture of other products including portland cement, pottery and agricultural chemicals.

The only producer of portland cement in South-East Queensland is the Queensland Cement & Lime Co. Ltd., at Darra.

Queensland Cement & Lime Co. Ltd.

The major constituent of the cement produced is coral obtained from Mud Island in Moreton Bay, beyond the limits of the accompanying map.

Quaternary alluvial plastic clay in shades of red and brown from M.L. 993 (366101; Map Sheet 2) and Tertiary clay/shale from M.L. 272 (405105; Map Sheet 2) are used at the rate of 20,000 to 30,000 tons annually. In the period 1952-64, 322,390 tons of clay, valued at £173,120, were processed.

Sand is obtained at the rate of 40,000 to 50,000 tons per year from a pit near Sandy Creek, south-east of Gailes, beyond the limits of the City.

Numerous small potteries and pottery schools in the City are using local pottery clays. The largest pottery is that of R. Fowler Ltd., manufacturers of all types of toilet and sanitary ware, but no local raw materials are used.

Industrial Minerals Co. Pty. Ltd.

This company holds one mineral lease in the City, M.L. 332 (Map Sheet 1), which is worked for clay for use in small potteries and pottery schools and as a carrier of agricultural chemicals.

In the period 1953-64, 2,443 tons of clay, valued at £3,555, were won. Production in 1964 was 200 tons.

Minerals (Qld) Pty. Ltd.

This company currently holds mineral leases M.L. 990 and 991 (Map Sheet 1) but no information is available from the company concerning its operations.

POTENTIAL

A number of potential deposits of clay materials have been located in the City and these are described briefly below.

The Deposits Cl 1 to Cl 23 were selected because they contained more than 130,000 cu. yd of clay material suitable for use in the ceramic industry overlain by less than 12 ft of overburden. Deposits Cy 1 to Cy 3 were selected for their bloating clay content. The "Minor Occurrences" are small deposits which could have potential where smaller quantities of a certain clay are required for some special purpose.

Delineation of the defined deposits was based on the results of firing tests carried out on samples from auger holes. The descriptions of the deposits are intended only as a guide to the prospector and closely spaced drilling should be done in any area selected for production to prove accurately the total reserves before quarrying operations are commenced. It must also be remembered that the firing tests were carried out with small hand made tablets, not on pressed bricks, and that laboratory firing cannot fully simulate conditions existing in a kiln. Thus, pressed bricks made from the same materials and fired in a kiln could differ somewhat in colour and shrinkage from the tablets fired in the laboratory and described in Table IX.

In general, the Triassic clay materials are quartz-kaolinite clays with minor amounts of a mixed layer mineral consisting of inter-layered montmorillonite clay minerals and a mica-like mineral. The Tertiary and Recent clays generally contain large amounts of the mixed layer mineral with some kaolinite (Ferguson, 1954).

The chief uses for which these materials are suitable are the manufacture of bricks, tiles, pipes and common pottery. A few of the samples appeared suitable for the making of pottery or whiteware or for bloating, and the locations of these samples are given in Table II.

Deposit Cl 1 (192097; Map Sheet 2)

Three shallow auger holes [Table VIII (1)] were drilled in this area and intersected from 15 to 27 ft (average 22 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible and only BMP 727 reached the base of the ceramic clay materials. No water was met in the holes.

The strata believed to be suitable for use in the ceramic industry included grey, red, blue-grey and black (carbonaceous) plastic clay and grey decomposed shale of the Triassic Tivoli-Cooneana Formations undifferentiated.

UTILISATION: No samples from this deposit were fired but the clay materials are expected to prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 22 ft over an area of 16 acres, are about 568,000 cu. yd.

LAND AVAILABILITY: The area is undeveloped, readily accessible and of negligible relief, about 100 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 2 (435100; Map Sheet 2)

Almost the entire area of outcrop of the Darra Formation in the type area could be classed as a clay deposit but only the undeveloped parts of the area were investigated.

Forty-five shallow auger holes [Table VIII (2)] were drilled in this area and 33 of them intersected clay. Of the 41 holes in the undeveloped south-western part of the area, 29 intersected from 6 to 30 ft (average 20 ft) of clay. In general, overburden was negligible but in a few holes from 5 to 16 ft of pebbly clay, sand, sandstone and/or clayey sand were found overlying the ceramic clay.

The usable clay was dominantly grey, brown and fawn with yellowish, reddish and greenish bands common. Most of it was plastic, commonly sandy or silty. Thin ferruginous beds containing siliceous ironstone nodules were met in most of the holes but they did not appear to affect the firing properties of the clays.

UTILISATION: Firing tests were carried out on 88 samples and the results [Table IX (1)] indicate that the clays from the area should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery with selected material suitable also for making whiteware.

LAND AVAILABILITY: The north-western part of the Darra Formation outcrop area is closely subdivided as is the strip of land along Ipswich Road. There are areas of vacant land in the south-west but much of the eastern part of the deposit is occupied by three brickworks.

PRODUCTION: Parts of this deposit have been worked for a number of years by Brittains Bricks & Pipes Pty. Ltd. (p. 7), Oxley Brickworks Pty. Ltd. (p. 7), Ralph Brittain & Co. Pty. Ltd. (p. 6) and the Queensland Cement & Lime Co. Ltd. (p. 10).

Deposit Cl 3 (532130; Map Sheets 1 and 2)

Thirteen shallow auger holes [Table VIII (3)] were drilled in this area and intersected from 18 to 30 ft (average 26 ft 6 in.) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 641 which penetrated 9 ft of decomposed sandstone at the surface. Most of the holes reached the base of the ceramic clay and passed into clay unsuitable for ceramics or into basalt. Water generally occurred at the base of the clay.

The strata believed to be suitable for use in the ceramic industry were Tertiary and Quaternary plastic clays in shades of brown with interbedded grey and red bands. A few gypsum crystals were found in some of the upper beds.

UTILISATION: Firing tests were carried out on three samples and the results [Table IX (2)] indicate that the clays described above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery although the shrinkage of some samples was high.

RESERVES: Reserves, estimated on an average thickness of 26 ft 6 in. over an area of 155 acres, are about 6,627,000 cu. yd. The clay appears to thin to the south and overburden thickens to the south-west. The deposit may extend northwards as far as Stable Swamp Creek.

LAND AVAILABILITY: The area is undeveloped except along Ipswich Road. It is low-lying, about 25 ft above sea level, and is readily accessible except during heavy rain or at flood-time.

PRODUCTION: Nil.

Deposit Cl 4 (533050; Map Sheets 1 and 2)

Nine shallow auger holes [Table VIII (4)] were drilled in this area and intersected from 9 to 30 ft (average 19 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except along Bowhill Road where 6 to 9 ft of loam was met at the surface. In general, the holes bottomed in sand with water occurring at the base of the clays.

The clays were dominantly brown and grey, plastic and of presumed Tertiary age.

UTILISATION: Firing tests were carried out on three samples [Table IX (3)] and the results indicate that the above clays should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery although the shrinkage of some samples was high.

RESERVES: Reserves, estimated on an average thickness of 19 ft over an area of 195 acres, are about 5,977,000 cu. yd.

LAND AVAILABILITY: Scattered dwellings and farms occupy this area which is low-lying, about 25 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 5 (595032; Map Sheet 1)

Sixteen shallow auger holes [Table VIII (5)] were drilled in this area and intersected from 9 to 30 ft (average 18 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 318 where 9 ft of decomposed sandstone occurred at the surface. The base of the ceramic clay materials was reached in six holes at from 9 to 21 ft. Water was met in BMP 983 at 24 ft.

One diamond drillhole, Brisbane N.S. 3, was sunk at 597028 and from 10 ft to 109 ft 8 in. penetrated clay materials similar to those met in the auger holes (Houston, 1967, Appendix III).

The strata believed to be suitable for use in the ceramic industry included grey, brown and reddish plastic clay and brown to red siltstone, hard in part. In N.S. 3 the section was of interbedded shale, clay and siltstone of the Tertiary Darra Formation.

UTILISATION: Firing tests were carried out on six samples and the results [Table IX (4)] indicate that the clay materials described above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery although a few thin beds appear suitable for brick-making only.

RESERVES: Minimum reserves, estimated on an average thickness of 18 ft over an area of 260 acres, are about 7,550,000 cu. yd. The thickness of the section in Brisbane N.S. 3 indicates that actual reserves in the deposit may be considerably greater.

LAND AVAILABILITY: The area is from 50 to 150 ft above sea level and is undeveloped except for a few dwellings along Learoyd Road.

PRODUCTION: Nil.

Deposit Cl 6 (725086; Map Sheet 1)

Five shallow auger holes [Table VIII (6)] were drilled in this area and intersected from 12 to 33 ft (average 19 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible. Two holes (BMP 280 and BMP 290) reached the base of ceramic clays at 12 ft. Water was met in BMP 287 at 12 ft.

The strata believed to be suitable for use in the ceramic industry included brown, red, greenish, black or purplish Tertiary plastic clay which was sandy in part. Fragments of decomposed basalt occurred in some of the beds and these increased in abundance with depth.

UTILISATION: Firing tests were carried out on eight samples [Table IX (5)] and the results indicate that the above clays should prove generally suitable for the manufacture of bricks with selected beds suitable also for making tiles, pipes and common pottery.

RESERVES: Minimum reserves, esitmated on an average thickness of 19 ft over an area of 50 acres, are about 1,533,000 cu. yd.

LAND AVAILABILITY: The area is about 100 to 200 ft above sea level, readily accessible and is occupied by small farms.

PRODUCTION: Nil.

Deposit Cl 7 (780050; Map Sheet 1)

Twenty-five shallow auger holes [Table VIII (7)] were drilled in this area and intersected from 3 to 30 ft (average 18 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 250 where 18 ft of non-ceramic clay overlay the ceramic clay materials. Many of these holes bottomed in sandstone or basalt. Water was met in seven holes at from 6 to 24 ft.

The strata believed to be suitable for use in the ceramic industry included Tertiary plastic clay, dominantly grey and brown, with some greenish, yellowish or reddish beds, siltstone and decomposed basalt.

UTILISATION: Firing tests were carried out on 38 samples from this deposit and the results [Table IX (6)] indicate that the ceramic clay materials above

should prove generally suitable for the manufacture of bricks with selected parts of the deposit suitable for making tiles, pipes and common pottery also. Two samples bloated (Table II).

RESERVES: Reserves, estimated on an average thickness of 18 ft over an area of 480 acres, are about 13,939,000 cu. yd.

LAND AVAILABILITY: The area is about 150 to 200 ft above sea level and readily accessible. Fairly close settlement has taken place along Millers Road and along Logan Road between School and Levington Roads. The remainder of the area is occupied by small farms.

PRODUCTION: Nil.

TABLE I

*DISTRIBUTION OF CLAY SAMPLES WHICH FIRED TO WHITE, OFF-WHITE OR CREAM COLOURS

Fired at:		900°C	1,000°C	1,100°C	1,200°C	1,300°C
Deposit Cl 6: Eight Mile Plains	†BMP 280	–	–	–	x	x
	BMP 287	–	–	–	x	x
	BMP 288	–	–	x	–	–
Deposit Cl 7: Eight Mile Plains	BMP 229	x	x	x	x	x
Deposit Cl 9: Rochedale	BMP 214	x	x	x	x	–
Deposit Cl 11: Upper Tingalpa	BMP 201	–	–	x	–	–
	N.S. 9	–	–	x	–	–
Deposit Cl 12: Rochedale	BMP 208	–	–	–	–	x
	BMP 226	–	–	–	x	x
	N.S. 14	x	x	x	x	x
Deposit Cl 14: Gumdale	BMP 368	x	x	x	x	–
Deposit Cl 17: Aspley	BMP 24, BMP 28	x	–	–	–	–
Deposit Cl 20: Brighton	BMP 476	–	–	x	–	x
	BMP 527	–	–	–	–	x
Deposit Cl 23: Bald Hills	BMP 405	–	–	–	x	–
	BMP 407	–	–	x	x	–
	BMP 412	–	–	x	x	x
	BMP 413	x	–	x	x	x
Minor Occurrences:						
Belmont	BMP 190	x	x	x	x	x
Upper Tingalpa	BMP 202	–	–	x	x	–
Rochedale	BMP 217	–	–	–	x	x
Eight Mile Plains	BMP 228	x	x	x	x	x
Tingalpa	BMP 352	x	x	x	x	x
Aspley	BMP 416	–	x	x	–	–
Carina	BMP 592	x	x	x	x	x
Runcorn	BMP 612	x	x	x	x	–
Oxley	BMP 685	–	–	–	x	x
Mt. Ommaney	BMP 783	x	x	x	x	x

* Similar lithologies from the same geological units in the same general areas as those from which the tested samples were taken should give similar results under comparable conditions of firing.

† For details see Table IX.

Deposit Cl 8 (850055; Map Sheet 1)

Sixteen shallow auger holes [Table VIII (8)] were drilled in this area and intersected from 13 to 42 ft (average 29 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 157 where 12 ft of decomposed sandstone were penetrated at the surface. On the eastern side of the deposit water was met at from 18 to 30 ft.

One diamond drillhole, Brisbane N.S. 7/12, was sunk at 850060 and from 5 ft to 85 ft 7 in. intersected clay materials similar to those met in the auger holes (Houston, 1967; Appendix III).

The strata believed to be suitable for use in the ceramic industry included grey, red and brown plastic Triassic clay with minor white and black (carbonaceous) bands, dark grey to black clay shale and minor shale and siltstone. Brisbane N.S. 7/12 intersected clay, carbonaceous shale and minor siltstone and coal of Triassic age.

UTILISATION: Firing tests were carried out on 12 samples from this deposit and the results [Table IX (7)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks and common pottery with the bulk of the material suitable also for making tiles and pipes.

RESERVES: Minimum reserves, estimated on an average thickness of 29 ft over an area of 60 acres, are about 2,807,000 cu. yd. The thickness of the ceramic clays in N.S. 7/12 indicates that actual reserves are considerably greater.

LAND AVAILABILITY: The area is readily accessible, undeveloped and from less than 150 to 200 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 9 (880071; Map Sheet 1)

Fourteen shallow auger holes [Table VIII (9)] were drilled in this area and intersected from 12 to 30 ft (average 25 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 103 and BMP 146 where 8 and 10 ft respectively of sandstone were met at the surface. In general, the holes did not reach the base of the ceramic clay materials. Water was encountered at 15 to 18 ft in the vicinity of Priest's Gully.

One deep auger hole, Brisbane N.S. 6, was drilled near the centre of the deposit to a depth of 59 ft and intersected 43 ft of ceramic clays [Table VIII (9)].

The strata from the shallow holes believed to be suitable for use in the ceramic industry included clay which was dominantly plastic, grey and brown in colour with some red, bluish and black (carbonaceous) bands and grey and brown shale which was carbonaceous or coaly in part. The section in Brisbane N.S. 6 included clay, shale, siltstone and very fine-grained sandstone of Triassic age [Tingalpa Formation].

UTILISATION: Firing tests were carried out on 10 samples from this deposit and the results [Table IX (8)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks with selected beds suitable also for making tiles, pipes, common pottery and whiteware.

RESERVES: Minimum reserves, estimated on an average thickness of 25 ft over an area of 85 acres, are about 3,428,000 cu. yd. The thickness of the section in N.S. 6 indicates that actual reserves are considerably greater.

LAND AVAILABILITY: There are only a few scattered dwellings in this area which is readily accessible and about 150 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 10 (925083; Map Sheet 1)

Six shallow auger holes [Table VIII (10)] were drilled in the lower-lying parts of this area and intersected only surface deposits of alluvial clay.

Interest in the deposit is confined to the decomposed phyllite which crops out at the intersection of Alperton and Kloske Roads and extends about ½ mile north-east from there. The rock contains only rare quartz veins and could therefore be readily crushed. A marked cleavage dips steeply to the south-west.

One deep auger hole, Brisbane N.S. 8 [Table VIII (10)], was drilled in this material and intersected 26 ft of completely decomposed phyllite before passing into harder rock.

No firing tests were carried out on samples of this material but a few test bricks were made and kiln-fired at about 1,000°C by a local company. The fired bricks were a deep red colour not commonly seen in the firing of local clay materials. If bricks were to be made from the decomposed phyllite, the admixture of small quantities of plastic clay might prove advantageous.

The area is fairly accessible, undeveloped and from 100 to 200 ft above sea level.

This deposit has not been worked commercially.

Deposit Cl 11 (920118; Map Sheet 1)

Fifteen shallow auger holes [Table VIII (11)] were drilled in this area and intersected from 18 to 33 ft (average 25 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible and few of the holes reached the base of the ceramic clay materials. Water was met in BMP 968 and BMP 970, close to Priest's Gully.

One deep auger hole, Brisbane N.S. 9 [Table VIII (11)] was drilled to a depth of 56 ft and intersected 50 ft of clay materials similar to those met in the shallow holes with a 1 ft band of gravel near the middle of the section.

The strata believed to be suitable for use in the ceramic industry included grey, brown, red or yellow plastic Triassic clay and grey, brown or black shale which was commonly carbonaceous and/or coaly.

UTILISATION: Firing tests were carried out on nine samples from this deposit and the results [Table IX (9)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks. tiles, pipes and common pottery with selected material suitable also for making pottery and whiteware.

RESERVES: Minimum reserves, estimated on an average thickness of 25 ft over an area of 125 acres, are about 5,042,000 cu. yd. The thickness of the section in Brisbane N.S. 9 indicates that actual reserves are considerably greater.

LAND AVAILABILITY: The area is undeveloped, readily accessible and about 50 to 100 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 12 (840145; Map Sheet 1)

Sixty shallow auger holes were drilled in this area [Table VIII (12)] and intersected from 6 to 51 ft (average 26 ft 6 in.) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 87, BMP 98, BMP 100, BMP 117 and BMP 223 which penetrated from 6 to 15 ft of sandstone at or near the surface. A few holes bottomed in thick sandstone beds but the majority did not reach the base of the ceramic clay materials. Water was met at about 30 ft in three holes.

One diamond drillhole, Brisbane N.S. 14 (Houston, 1967; Appendix III), was sunk near the centre of the deposit and penetrated 96 ft clay materials similar to those met in the auger holes. A number of percussion holes sunk in this area in the search for water also penetrated sections of clays about 100 ft thick.

The strata believed to be suitable for use in the ceramic industry included shale and clay, with minor interbedded siltstone, of the Triassic Tingalpa Formation. The shale was grey and brown with abundant carbonaceous and coaly bands; the clay was dominantly plastic, slightly silty in part, grey and brown with some red, white and black (carbonaceous) bands.

UTILISATION: Firing tests were carried out on 31 samples and the results [Table IX (10)] indicate that the clay materials described above should prove generally suitable for the manufacture of bricks, tiles and common pottery with selected material suitable also for making pipes, whiteware, pottery and/or firebricks.

RESERVES: Minimum reserves, estimated on an average thickness of 26 ft 6 in. over an area of 1,645 acres, are about 70,329,000 cu. yd. The thickness of ceramic clays found in the deeper holes indicates that actual reserves are very much greater than this.

LAND AVAILABILITY: Much of the area is occupied by small farms and scattered dwellings and in the western part there are eight current mineral leases. The deposit is readily accessible and about 75 to 200 ft above sea level.

PRODUCTION: Part of this deposit is currently worked by Brickworks Ltd. (p. 6) and Wunderlich Ltd. (p. 9). A small brickworks was established by Mr. H. Williams at the corner of Mt Petrie Road and Weedon Street (M.L. 292) but it is now abandoned. Only 44 tons of shale have been won from this lease.

Deposit Cl 13 (775175; Map Sheets 1 and 3)

Thirty-nine shallow auger holes [Table VIII (13)] were drilled in this area and intersected from 6 to 42 ft (average 25 ft 6 in.) of clay materials believed to be suitable for use in the ceramic industry. Overburden is variable and in eleven scattered holes from 6 to 12 ft of sandstone, gravel or sandy clay were met at or near the surface. Eight holes bottomed in sandstone, gravel or sand and two in the north bottomed in hard tuff but the remainder did not reach the base of the ceramic clay materials. Water was met in four holes at from 18 to 30 ft.

The strata believed to be suitable for use in the ceramic industry included dominantly plastic, brown, grey, blue-grey, reddish or, rarely, black (carbonaceous) Triassic clay and decomposed shale which was grey, brown or black (carbonaceous or coaly). The clay was rarely sandy or silty and minor brown or red siltstone occurred interbedded.

UTILISATION: Firing tests were carried out on 12 samples from this area and the results [Table IX (11)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery with selected material suitable also for making whiteware and/or pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 25 ft 6 in. over an area of 905 acres, are about 36,502,000 cu. yd.

LAND AVAILABILITY: This deposit is readily accessible and dominantly 100 to 200 ft above sea level. A considerable part of the area was recently released for subdivision.

PRODUCTION: Nil.

Deposit Cl 14 (965280; Map Sheet 3)

Eighteen shallow auger holes [Table VIII (14)], were drilled in this area and intersected from 15 to 51 ft (average 27 ft) of clay materials believed to be suitable for use in the ceramic industry. Overburden was negligible and a number of the holes bottomed in sandstone or basalt. Water was met in eight holes at from 6 to 51 ft.

One diamond drillhole, Brisbane N.S. 29 (Houston, 1967; Appendix III), was sunk to a depth of 180 ft but recovery in the upper part of the section was very poor so it was of little use in evaluating this deposit.

The strata believed to be suitable for use in the ceramic industry included grey, brown and red Tertiary clay which was generally plastic and rarely sandy and minor grey shale and siltstone.

UTILISATION: Firing tests were carried out on three samples from this deposit and the results [Table IX (15)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 27 ft over an area of 400 acres, are about 17,424,000 cu. yd.

LAND AVAILABILITY: The area is low-lying, dominantly about 25 ft above sea level, and a few homes are the only development.

PRODUCTION: Nil.

Deposit Cl 15 (327465; Map Sheet 4)

Seven shallow auger holes [Table VIII (15)], were drilled in this deposit and intersected from 7 to 27 ft (average 15 ft) of clays believed to be suitable for use in the ceramic industry. Up to 9 ft of non-commercial clay, together with sand and gravel, occur as overburden and most of the holes bottomed in pebbly clay or other clay unsuitable for ceramic use. Water was met at 20 ft in one hole.

The strata believed to be suitable for use in the ceramic industry included semi-plastic, grey to brown and, rarely, black alluvial clays which were slightly sandy and pebbly in part.

UTILISATION: Firing tests were carried out on four samples from this deposit and the results [Table IX (13)] indicate that the ceramic clays above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery.

RESERVES: Reserves, estimated on an average thickness of 15 ft over an area of 45 acres, are about 1,089,000 cu. yd.

LAND AVAILABILITY: The area is undeveloped except for scattered dwellings, is readily accessible and is about 200 to 250 ft above sea level.

PRODUCTION: Nil. Similar materials to these were formerly worked by Wunderlich Ltd. at 375499 for the manufacture of terracotta roofing tiles (p. 9).

Deposit Cl 16 (380457; Map Sheet 4)

Eight shallow auger holes [Table VIII (16)], were drilled in this area and intersected from 6 to 42 ft (average 19 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 841 and BMP 870 at the tops of which 9 ft of soil, clay and sand and 6 ft of sand and loam were met respectively. Four holes bottomed in decomposed granite at from 24 to 27 ft and two bottomed in thick sand. Water was met in six holes at from 9 to 18 ft.

The strata believed to be suitable for use in the ceramic industry included brown, grey, blue or black alluvial clays which were dominantly sandy and plastic in part.

UTILISATION: Firing tests were carried out on seven samples from this deposit and the results [Table IX (14)] indicate that the ceramic clays above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery with selected material suitable for bloating.

RESERVES: Reserves, estimated on an average thickness of 19 ft over an area of 21 acres, are about 644,000 cu. yd.

LAND AVAILABILITY: The area is undeveloped except for scattered dwellings, is readily accessible and is about 200 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 17 (582565; Map Sheet 5)

Seventeen shallow auger holes [Table VIII (17)] were drilled in this area and fourteen of them intersected from 6 to 30 ft (average 19 ft) of clay materials believed to be suitable for use in the ceramic industry underlying negligible overburden. Some of the holes in the east bottomed in limestone and some in the south-west finished in sandstone. No water was met.

The strata believed to be suitable for use in the ceramic industry included clay, shale and siltstone of the Triassic Tingalpa Formation. The clay was generally plastic, brown, grey, red, white or black in colour, carbonaceous in part and sandy in part. The shale was brown or grey in colour and commonly carbonaceous; the siltstone was grey, slightly micaceous in part.

UTILISATION: Firing tests were carried out on seven samples from this deposit and the results [Table IX (15)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery.

RESERVES: Reserves, estimated on an average thickness of 19 ft over an area of 16 acres, are about 490,000 cu. yd.

LAND AVAILABILITY: The entire area has recently been subdivided and is now closely settled.

PRODUCTION: Nil.

Deposit Cl 18 (668645; Map Sheet 5)

Five shallow auger holes [Table VIII (18)] were drilled in this area and intersected from 15 to 24 ft (average 21 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible and none of the holes reached the base of the ceramic clays. No water was met.

The strata believed to be suitable for use in the ceramic industry were grey, brown or red plastic Tertiary and Quarternary clays.

UTILISATION: Firing tests were carried out on three samples from this deposit and the results [Table IX (16)] indicate that the ceramic clays above should prove generally suitable for the manufacture of bricks with selected material suitable also for making tiles, pipes, common pottery and/or whiteware.

RESERVES: Minimum reserves, estimated on an average thickness of 21 ft over an area of 130 acres, are about 4,404,000 cu. yd.

LAND AVAILABILITY: Suburban residences occupy the margins of this deposit and a fringe along Roghan Road but the remainder of the area is undeveloped. It is from less than 25 to 50 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 19 (650695; Map Sheet 5)

Twenty-one shallow auger holes [Table VIII (19)] were drilled in this area and intersected from 18 to 36 ft (average 25 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 532 where 9 ft of sandy clay was met at the surface. Three holes bottomed in sand, one in sandstone and one in basalt; the remainder did not reach the base of the ceramic clays. Water was met in nine randomly located holes at from 21 to 30 ft.

The above clays were plastic, grey, brown, pinkish, red, blue-grey, greenish, yellowish or whitish and, rarely, sandy. They are ascribed to the Tertiary and Quaternary.

UTILISATION: Firing tests were carried out on four samples from this deposit and the results [Table IX (17)] indicate that the ceramic clays above should prove generally suitable for the manufacture of bricks with selected material suitable also for making tiles, pipes and common pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 25 ft over an area of 310 acres, are about 12,503,000 cu. yd.

LAND AVAILABILITY: This area is a low-lying one of negligible relief dominantly less than 25 ft above sea level but rising to 50 ft in the south-western corner. It is mainly undeveloped with a few dwellings along the main roads.

PRODUCTION: Nil.

TABLE II

*DISTRIBUTION OF CLAY SAMPLES WHICH, FROM FIRING TESTS, APPEAR SUITABLE FOR THE MANUFACTURE OF WHITEWARE & POTTERY OR FOR BLOATING

		Whiteware	Pottery	Bloating
Deposit Cl 2: Darra	†BMP 1691	x	–	–
	BMP 1692	x	–	–
	BMP 1693	x	–	–
	BMP 1697	x	–	–
	BMP 1708	x	–	–
Deposit Cl 5: Acacia Ridge	N.S. 3	x	–	–
Deposit Cl 7: Eight Mile Plains	BMP 246	–	–	semi
	BMP 272	?	?	–
Deposit Cl 8: Rochedale	N.S. 7/12	–	–	x
Deposit Cl 9: Rochedale	BMP 214	x	–	–
	N.S. 6	x	–	–
Deposit Cl 11: Upper Tingalpa	BMP 201	x	–	–
	N.S. 9	x	x	–
Deposit Cl 12: Rochedale	BMP 208	x	–	–
	BMP 226	x	–	–
	N.S. 14	x	x	–
Deposit Cl 13: Mt Gravatt–Belmont	BMP 329	x	–	–
	BMP 333	x	–	–
	BMP 351	x	x	–
	BMP 600	x	–	–
Deposit Cl 16: Ferny Grove	BMP 871	–	–	x
Deposit Cl 18: Boondall	BMP 524	x	–	–
Deposit Cl 20: Brighton	BMP 476	x	–	–
	BMP 527	x	–	–
Deposit Cl 22: Bald Hills	BMP 457	x	–	–
Deposit Cl 23: Bald Hills	BMP 405	x	–	–
	BMP 412	x	–	–
	BMP 413	x	–	–
	BMP 431	–	–	x
Deposit Cy 1: Lytton	BMP 575	–	–	x
Deposit Cy 2: Bulwer Island	BMP 548	–	–	x
	BMP 565	–	–	x
Deposit Cy 3: Bald Hills	BMP 446	–	–	x
Minor Occurrences:				
Belmont	BMP 190	x	x	–
Upper Tingalpa	BMP 202	x	–	–
Eight Mile Plains	BMP 228	x	–	–
Kuraby	BMP 259	x	x	x
Mt Gravatt	BMP 328	x	–	–
Belmont	BMP 343	x	–	–
Gumdale	BMP 352	x	x	–
	BMP 358	x	x	–
Bald Hills	BMP 425	–	–	fair
	BMP 453	–	–	x
Geebung	BMP 517	–	–	semi
Zillmere	BMP 522	–	–	x
Carina	BMP 587	x	–	–
	BMP 592	x	x	–
Runcorn	BMP 612	x	x	–
Oxley	BMP 685	x	–	–
Mt Ommaney	BMP 783	x	x	–
Ferny Grove	BMP 844	–	–	x
	BMP 846	–	–	x

* Similar lithologies from the same geological units in the same general areas as those from which tested samples were taken should give similar results under comparable conditions of firing.

† For details see Table IX.

Deposit Cl 20 (650735; Map Sheet 5)

Eight shallow auger holes [Table VIII (20)] were drilled in this area and intersected from 12 to 27 ft (average 2 ft 6 in.) of clay materials believed to be suitable for use in the ceramic industry underlying negligible overburden. None of the holes reached the base of the ceramic clay materials and no water was encountered.

The strata believed to be suitable for use in the ceramic industry were Jurassic siltstone, shale and clay. The siltstone was grey, brown, red or yellowish and micaceous in part. The clay was red, grey or brown, silty in part and the shale was brown.

UTILISATION: Firing tests were carried out on two samples from this deposit and the results [Table IX (18)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks with selected material suitable for making tiles, pipes, common pottery and whiteware also.

RESERVES: Minimum reserves, estimated on an average thickness of 22 ft 6 in. over an area of 140 acres, are about 4,969,000 cu. yd.

LAND AVAILABILITY: The area is about 25 to 75 ft above sea level and residential development has taken place along the major roads. It is otherwise undeveloped.

PRODUCTION: Nil.

Deposit Cl 21 (572730; Map Sheet 5)

Thirteen shallow auger holes [Table VIII (21)] were drilled in this area and intersected from 15 to 30 ft (average 22 ft 6 in.) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except in BMP 1118 where 9 ft of pebbly sand were met at the surface. Many of the holes bottomed in sand, sandstone or gravel but seven of them did not reach the base of the ceramic clays. Water was encountered at from 18 to 30 ft in six holes.

The ceramic clays were plastic and, rarely, sandy, dominantly brown with some grey-brown, red-brown, yellow-brown, blue-grey, red, green and black bands. They are of Quaternary and probable Tertiary age.

UTILISATION: Firing tests were carried out on one sample only from this deposit and the results [Table IX (19)] indicate that the ceramic clays above should prove generally suitable for the manufacture of bricks, tiles, pipes and common pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 22 ft 6 in. over an area of 155 acres, are about 5,626,000 cu. yd.

LAND AVAILABILITY: This undeveloped area is low-lying being less than 25 ft to about 25 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 22 (595670; Map Sheet 5)

Twenty-seven shallow auger holes [Table VIII (22)] were drilled in this deposit and intersected from 12 to 30 ft (average 23 ft) of clays believed to be suitable for use in the ceramic industry. Overburden was negligible except in the following:—BMP 421 (9 ft of red-brown clay with ironstone nodules); BMP 422 (21 ft of grey, brown and chocolate clay which cracked badly when fired); BMP 457 (12 ft of sandstone); BMP 464 (9 ft of sandy clay). Many of the holes bottomed in non-commercial green calcareous clay or shale. Water was encountered in six holes at from 12 to 24 ft.

One diamond drillhole, Brisbane N.S. 19 (Houston, 1967; Appendix III), was sunk at 588656, near the south-western margin of the deposit. The mudstone section from 7 to 103 ft may be suitable for ceramic use but no samples from it were fired.

Evaluation of this Tertiary deposit is problematical as firing tests on lithologically similar samples showed that some were suitable for use in the ceramic industry and that others were not. The grey, brown, red, red-brown and chocolate clays are believed to be generally suitable for use.

UTILISATION: Firing tests were carried out on nine samples from this deposit and the results [Table IX (20)] indicate that the clays listed above should prove generally suitable for the manufacture of bricks with selected material suitable also for making tiles, pipes, common pottery and whiteware.

RESERVES: Minimum reserves, estimated on an average thickness of 23 ft over an area of 525 acres, are expected to be about 19,481,000 cu. yd. The thickness of probable ceramic clays in N.S. 19 indicates that actual reserves may be greater.

LAND AVAILABILITY: The area is, for the most part, undeveloped and is dominantly about 50 ft above sea level.

PRODUCTION: Nil.

Deposit Cl 23 (535645; Map Sheet 5)

Forty shallow auger holes [Table VIII (23)] were drilled in this area and intersected from 9 to 36 ft (average 24 ft 6 in.) of clay materials believed to be suitable for use in the ceramic industry. Overburden was of 3 to 6 ft of loam except in BMP 401 which passed through 15 ft of sandstone and sandy clay before reaching ceramic clays. Few of the holes reached the base of the ceramic clays. Water was met in four holes at from 24 to 36 ft.

One deep auger hole, Brisbane N.S. 10 (Houston, 1967; Appendix III), was drilled at 523640 and reached the base of the ceramic clay materials at 63 ft.

The strata believed to be suitable for use in the ceramic industry included Tertiary (Petrie Formation) clay and minor grey, white or red siltstone. The clay was dominantly plastic and grey or brown in colour with red, purplish, yellow-brown, green and black (carbonaceous or coaly) bands interbedded.

UTILISATION: Firing tests were carried out on 18 samples from this deposit and the results [Table IX (21)] indicate that the ceramic clay materials above should prove generally suitable for the manufacture of bricks and most of the material suitable also for making tiles, pipes and common pottery.

RESERVES: Minimum reserves, estimated on an average thickness of 24 ft 6 in. over an area of 980 acres, are about 38,736,000 cu. yd. The thickness of the section in Brisbane N.S. 10 indicates that actual reserves are greater.

LAND AVAILABILITY: This area, which is about 50 to 150 ft above sea level, is for the most part undeveloped but south of Beams Road subdivision is gradually spreading westwards. The Pinaroo Lawn Cemetery occupies about 120 acres of this deposit to the south and west of 523640 (Brisbane N.S. 10).

PRODUCTION: Nil.

Deposit Cy 1 (865440; Map Sheet 3)

Three auger holes [Table VIII (24)] were drilled in this area and intersected from 12 to 15 ft of grey and black mud and silt. There was no overburden and the holes did not reach the base of the mud and silt. Water was met in one hole at 9 ft.

UTILISATION: One sample from this area was fired and the results [Table IX (22)] indicate that the mud and silt should prove generally suitable for bloating for the manufacture of lightweight aggregate.

RESERVES: This deposit was not fully tested but similar material to that tested is believed to occur in much of the delineated area. Estimated on an average thickness of 14 ft over an area of 345 acres, reserves are expected to be about 7,792,000 cu. yd.

LAND AVAILABILITY: The area is undeveloped and low-lying, being generally much less than 25 ft above sea level.

PRODUCTION: Nil.

Deposit Cy 2 (850460; Map Sheet 3)

Five auger holes [Table VIII (25)] were drilled in this area and intersected from 3 to 12 ft of mud and mudstone underlying from 0 to 15 ft of sand. The holes passed out of the "mud" into sand, and water was met in two holes at 6 and 12 ft respectively.

UTILISATION: Two samples from this deposit were fired [Table IX (23)]. The mud and mudstone should prove generally suitable for bloating for the manufacture of lightweight aggregate.

RESERVES: This deposit was not fully tested but similar material to that tested is believed to occur in much of the delineated area. Estimated on an average thickness of 7 ft over an area of 185 acres, reserves are expected to be of the order of 2,000,000 cu. yd.

LAND AVAILABILITY: The area is low-lying, being generally much less than 25 ft above sea level. The major part of it is now occupied by an oil refinery and other industrial development.

PRODUCTION: Nil.

Deposit Cy 3 (575750; Map Sheet 5)

Three auger holes [Table VIII (26)] were drilled in this area and intersected from 12 to 24 ft of black mud and green clay. Overburden was from 0 to 6 ft of sand and gravel and the holes did not reach the base of the mud. Water was met at about 6 ft in two of the holes.

UTILISATION: One sample from this deposit was fired and the results [Table IX (24)] indicate that the mud should prove suitable for bloating for the manufacture of lightweight aggregate.

RESERVES: Reserves, estimated on an average thickness of 17 ft over an area of 60 acres, are expected to be at least 1,600,000 cu. yd.

LAND AVAILABILITY: The area is undeveloped and low-lying, being much less than 25 ft above sea level.

Minor Occurrences

Clay materials suitable for use in the ceramic industry were intersected in 167 auger holes other than those listed above. These deposits are of only minor importance compared with those described but may be of interest where comparatively small quantities are required. Logs of these holes are given in Table VIII (27) and the results of firing tests carried out on samples from them are given in Table IX (25).

Ball (1932) recorded the presence of massive green and blue shale which he believed to be bentonitic on the spoil heap of a well at about 587680 (Map Sheet 5). As far as is known the deposit has not been further investigated.

IV. COAL

Coal is widespread in the Tivoli–Cooneana Formations undifferentiated and the Tingalpa Formation (formerly called Ipswich Coal Measures) but few workable seams have been discovered.

Stutchbury (1854) first recorded the presence of coal in the City of Brisbane and numerous prospecting shafts were subsequently sunk in the area (Ball, 1907). Prospecting has continued intermittently over the years but only at Moggill and Nundah have workable seams been located. Recent drilling by the Mines Department (Houston, 1967) located thick sections of coaly material in the Tingalpa Formation but the actual coal seams were only a few inches thick. Similar material has been described by Marks (1910) and Denmead (1953). Freytag (1963) reported on the reserves found in the Moggill area during a Mines Department drilling programme.

The collieries in the City are:—

Moggill Pit (286097; Map Sheet 2)

Coal in the City of Brisbane was first discovered by John Williams who opened the old Moggill Pit in 1848 and worked it for about 15 years (Gregory, 1876).

Lyon's Shaft (Map Sheet 2)

Lyon's Shaft was described by Gregory (1876) as being about a mile west-south-west of the Moggill Mine in portion 117, parish of Moggill (centred about 250097). The shaft has not been located.

Prior's Pit (251068; Map Sheet 2)

Prior's Pit was opened in the mid eighteen-fifties but had been abandoned for about fifty years when it was re-opened for a short period in 1913 (Ball, 1913). It was re-opened as the Sunset Mine in 1948 but had to be closed in 1950 due to severe faulting.

Riverside No. 1 Colliery (206064; Map Sheet 2)

Riverside No. 1 Colliery was opened in Moggill Pocket after the discovery of the Riverside No. 1 Seam in 1924 and was abandoned in 1931.

Moggill Colliery (213072; Map Sheet 2)

Riverside No. 2 Colliery commenced working in Riverside No. 2 Seam at an unknown date after 1924 and was abandoned prior to 1931. The colliery, now the Moggill Colliery, was re-opened in the mid nineteen-forties and is the only colliery working in the City of Brisbane today. It is a small producer working a banded seam of marginal quality which requires high discard from the washing plant

The Moggill Colliery, although located within the City of Brisbane, is worked as part of the Ipswich Coalfield.

Riverside No. 3 Colliery (190063; Map Sheet 2)

The Riverside No. 3 Colliery opened in the Riverside No. 1 Seam in 1931 and was abandoned in January 1947.

Nundah Colliery (656493; Map Sheet 3)

The Nundah Coal and Gravel Co. worked a 4 ft step-faulted seam of poor quality from 1895 to 1909 for a return of 1,803 tons valued at £466.

V. GEM MINERALS

The only gem minerals discovered in the City of Brisbane are a mineral closely resembling *turquoise* and *jasper*.

Stokes (1894) first recorded the presence of "turquoise" from a road cutting in Adelaide Street, City (605352; Map Sheet 3). Denmead (1928) recorded the presence of similar material filling cavities and joints in cherts of the Neranleigh–Fernvale "Group" at Victoria Park (593387; Map Sheet 3), Wilston (560452, 561432 and 561437; Map Sheet 3) and Stafford (536477; Map Sheet 3). He also found green stellate aggregates of *wavellite* associated with the "turquoise" at Wilston and Stafford.

Commercial quantities of this mineral are unknown.

Jaspers in shades of pink and red occur in the Upper Brookfield area but they are, in general, strongly fractured and not of gem quality. Less heavily fractured green and red jaspers occur at about 182394 (Map Sheet 4) and the deposit may warrant further prospecting.

VI. "GRANITE"

Adamellite and granodiorite of the Enoggera Granite are the only sources of "granite" in the City of Brisbane.

The adamellite was formerly worked in the Ashgrove area as building stone (Richards, 1918; Wolff, 1957). Two quarries only have been located. A small quarry at 448400 (Map Sheet 4) is abandoned and its history is unknown. Kerr's Quarry (450384; Map Sheet 4) was worked by W. Kerr for building and monumental stone until it was taken over by the Stirling Granite Co. [now The Readymix Group (Qld)] in the nineteen-fifties.

"Granite" suitable for use as "crushed rock" and decomposed "granite" are currently obtained from the area and potential deposits of both have been located.

"GRANITE"

Deposit G 1 (445378; Map Sheet 4)

South of the quarry at 450384 is an area of about 30 acres over much of which fresh "granite" crops out. The area is from 400 to 650 ft above sea level and the thickness of "granite" greater than could be exploited economically.

In the "Stirling Granite Quarry" (formerly Kerr's) at 450384 "granite" is currently worked by The Readymix Group (Qld). Crushed and screened rock is sold for a wide variety of uses including road construction and the manufacture of concrete building blocks. No further information is available from the company.

Deposit G 2 (418364; Map Sheet 4)

Fresh "granite" crops out over much of this 540 acre area which is from 200 to 900 ft above sea level. The area is undeveloped except at its northern end where suburban development is taking place in the vicinity of Paten and Payne Roads.

Deposit G 3 (410420; Map Sheet 4)

A greater than economically exploitable thickness of "granite" occurs in this 130 acre area between Settlement Road and Waterworks Road. The area is undeveloped and from 200 to 500 ft above sea level.

Similar material occurs in the western part of the Enoggera Rifle Range Reserve.

DECOMPOSED "GRANITE"

Deposit Gd 1 (391370; Map Sheet 4)

An average thickness of about 40 ft of decomposed "granite" occurs at the surface over much of this area. The deposit, which is about 280 acres, is from 200 to 800 ft above sea level and undeveloped except along the northern boundary.

Deposit Gd 2 (405460; Map Sheet 4)

North of the Enoggera-Waterworks Road, particularly along Settlement, Kedron and Samford Roads, decomposed granodiorite is being quarried. The weathered zone persists to at least 40 ft and a number of quarry sites are available.

Several small quarries have been worked along Samford Road but most have been abandoned or are only worked intermittently.

THIESS BROS. PTY. LTD. QUARRY (385470; Map Sheet 4) is currently worked for decomposed "granite" for use in road construction.

BOWSER AND LEVER PTY. LTD. QUARRY (414463; Map Sheet 4): no information is available from the company concerning its operations.

VII. GRAVEL

Surface deposits of gravel in the City of Brisbane are limited in number, extent and quality and the major source of gravel within the City is the bed of the Brisbane River. The known surface deposits are listed below and are shown on the accompanying maps.

Deposit Gv 1 (719976; Map Sheet 1)

More than 100 ft of interbedded sandstone and siliceous conglomerate of the Morooka Formation occur capping the ridges between 730965 and 709997, Woodridge–Runcorn. In general, these rocks are extremely decomposed and crush easily. The crushed material could be utilised as sand and gravel if screened.

The area is undeveloped and quarry sites are available but access to some of the higher hills may be difficult.

Numerous shallow pits have been worked in the area to remove the free gravel formed by the breakdown of the topmost conglomerate beds (Map Sheet 1).

Deposit Gv 2 (635174; Map Sheet 1)

This deposit is similar to that described above. About 20 ft of decomposed conglomerate and sandstone occur capping the hill which is undeveloped, readily accessible and an ideal quarry site.

Suburban subdivision is gradually encroaching on the area.

Deposit Gv 3 (900264; Map Sheet 3)

One auger hole [BMP 366; Table VIII (27)] was sunk in the City Council quarry about which this deposit is centred and 9 ft of conglomerate were intersected before passing into sandstone and shale. Like the conglomerate of Deposits Gv 1 and Gv 2 above, this rock could be readily crushed and screened.

The quarry is intermittently worked by the City Council to obtain free surface gravel for the maintenance of road shoulders.

Deposit Gv 4 (400150; Map Sheet 2)

Triassic siliceous conglomerate cropping out along the western margin of the Moorooka Formation between Seventeen Mile Rocks Road and Wolston Creek could be readily crushed and screened for use as gravel. The thickness and lateral extent of the individual beds is unknown but there appear to be considerable reserves in the area.

A number of small pits have been worked for the free gravel formed on the hilltops by the breakdown of the topmost conglomerate beds but these all appear to be abandoned.

Deposit Gv 5 (203102; Map Sheet 2)

This deposit number refers to all the outcrops of the Cainozoic Witty Gravel in the Moggill area. The unit is up to 30 ft thick and comprises semi-consolidated gravel with clay and decomposed sandstone interbedded. The gravels consist of angular to rounded phenoclasts (up to 2 ft in diameter) of quartzite, jasper, billy and minor basalt.

The area is undeveloped and accessible for quarrying operations except in the vicinity of the township of Moggill.

A number of small excavations have been made to work this material and, to a lesser extent, the Colleges Conglomerate but none are currently operating.

Brisbane River

Sand and gravel are dredged from the Brisbane River between Seventeen Mile Rocks and the William Jolly Bridge by a number of companies including Wm. Collin & Sons Pty. Ltd., Duncanson & Brittain Pty. Ltd., Gravel, Sand and Metal Supply Pty. Ltd., Kleinschmidt Bros. Pty. Ltd., Moreton Tug & Lighter Co. Pty. Ltd., W. Quince & Co. Pty. Ltd. and The Readymix Group (Qld).

The location and depth of dredging is controlled by the Department of Harbours and Marine and permits are issued by the Department subject to the payment of 9d. per cu. yd or £5 per week while pumping is in progress.

Minor Occurrences

Gravel similar to that of deposit Gv 1 is intermittently worked from a small pit at about 690960 (Map Sheet 1).

Gravel similar to that of Deposit Gv 5 is intermittently worked from a small pit at 338139, Jindalee (Map Sheet 2).

Remnants of a rather persistent Cainozoic gravel occur in the Goodna Mental Hospital Reserve (327030; Map Sheet 2) but reserves appear to be insufficient to warrant extraction.

Triassic gravel was formerly worked by the Nundah Coal and Gravel Co. from a pit at about 656493 (Map Sheet 3). Limited reserves are believed to remain.

A number of small gravel pits were formerly worked in the Gumdale–Tingalpa area (825307, 840300, 911249; Map Sheet 3) but supplies there are almost exhausted.

Siliceous gravel was obtained from workings on the northern slopes of Mt. Petrie (820255; Map Sheet 3) but reserves are negligible.

Thin gravel beds were intersected in a number of isolated auger holes sunk by the Mines Department in 1960-61. Lithologic logs and localities of these holes are given in Table III.

TABLE III

LITHOLOGIC LOGS OF DRILLHOLES

Minor Gravel Occurrences

Logs by: J. W. Laycock

BMP 383 (Grid Ref. 482627; Map Sheet 5)
0–12 ft GRAVEL: brown matrix, decomposed.
Remarks: Water (12 ft).

BMP 384 (Grid Ref. 492627; Map Sheet 5)
0– 3 ft CLAY: red, very sandy.
3– 6 ft CLAY: red and grey, very sandy.
6–12 ft GRAVEL: light grey; pebbles up to 1 in.; matrix very clayey.

BMP 389 (Grid Ref. 503644; Map Sheet 5)
0– 3 ft GRAVEL: numerous quartzite pebbles in brown matrix.

BMP 390 (Grid Ref. 504653; Map Sheet 5)
0– 6 ft GRAVEL: numerous quartzite pebbles in brown matrix.

BMP 403 (Grid Ref. 520620; Map Sheet 5)
0– 3 ft CONGLOMERATE: red; numerous quartz pebbles.

BMP 734 (Grid Ref. 250072; Map Sheet 2)
0– 6 ft CLAY: dark brown, plastic.
6–12 ft GRAVEL: numerous pebbles up to 1 in.
12–18 ft SILTSTONE: light grey, sandy.

BMP 742 (Grid Ref. 236130; Map Sheet 2)
0– 9 ft CONGLOMERATE: pebbles subangular to rounded up to ½ in.
9–12 ft SANDSTONE: light grey, medium-grained, decomposed.
12–15 ft CLAY: light grey-brown, plastic.
15–18 ft SANDSTONE: medium-brown, fine-to medium-grained, decomposed.

BMP 743 (Grid Ref. 238135; Map Sheet 2)
0– 6 ft CLAY: grey and brown, very sandy.
6–12 ft CONGLOMERATE: angular to subrounded pebbles up to ½ in.
12–18 ft. CLAY: medium brown, plastic.

BMP 764 (Grid Ref. 268075; Map Sheet 2)
0– 3 ft GRAVEL: boulders 1 ft plus; numerous basalt and billy pebbles.

BMP 782 (Grid Ref. 388129; Map Sheet 2)
0–12 ft CONGLOMERATE: rounded pebbles up to 1 in.; light grey, coarse-grained sandstone matrix.

BMP 1086 (Grid Ref. 599630; Map Sheet 5)
0– 9 ft GRAVEL: brown, clayey matrix, pebbles up to ¼ in.
9–15 ft CLAY: brown, very sandy.
15–24 ft CLAY: red, plastic, very sandy.
Remarks: Water (24 ft).

VIII. GREENSTONE

About 10 acres of greenstone (metamorphosed basic volcanics) overlain by greenstone-derived clay [Rocksberg Greenstones] occur to the north of Brackenridge (605715; Map Sheet 5). The greenstone is decomposed to a depth exceeding 30 ft and thus has no economic potential. On testing, however, the greenstone-derived clay appeared suitable for the manufacture of bricks, tiles and common pottery and for bloating.

Logs of drillholes sunk in this unit are given in Table VIII (27) and in Appendix I (BMP Nos. 453, 454, 470-473).

IX. GREYWACKE

Massive greywacke occurs in the Neranleigh–Fernvale "Group" in the Brookfield–Kenmore area (Map Sheets 2 and 4). These rocks are, in general, weathered at outcrop and to a depth of 20+ ft. They have some potential for use as aggregate but quarry sites would be difficult to locate owing to the depth of weathering, the topography and the encroaching subdivision.

Greywacke, together with quartzite and basic volcanics, was formerly worked in the *Mt. Ommaney Quarry* (359173; Map Sheet 2) [pp. 4, 26].

X. HORNFELS

Phyllites, sediments and volcanics which have been hornfelsed by the intrusion of the Enoggera Granite and allied intrusives or the Samford Granodiorite are ideal for use as "crushed rock" and for ornamental stone and paving work. They also have potential value as building stone.

BUNYA PHYLLITE

In the Bunya Phyllite there is a metamorphic aureole of the order of ¼ to ½ mile about the outcrop margin of the Enoggera Granite. A smaller aureole occurs about the small "granite" mass cropping out to the south of Mt. Coot-tha at 418285 (Map Sheet 4). Hornfelsed phyllite occurs at random in the Mt. Coot-tha area even at considerable distance from "granite" outcrops. The metamorphism of these rocks is attributed to the presence of buried plutonic rock.

The vertical thickness of the hornfels is undetermined but is expected to be greater than workable thickness except in the immediate vicinity of the "granite" margin at outcrop.

Deposit H 1 (420276; Map Sheet 4)

This is an area of about 45 acres, from 150 to 200 ft above sea level, which is undeveloped and readily accessible.

Deposit H 2 (438355; Map Sheet 4)

This is a reasonably accessible area of about 300 acres, from 200 to 600 ft above sea level. It is undeveloped and suitable sites for quarrying are available.

Deposit H 3 (370356; Map Sheet 4)

This area of about 350 acres is from 350 to 600 ft above sea level and, for the most part, undeveloped. Suitable sites for quarrying are available but access may be difficult.

Deposit H 4 (355450; Map Sheet 4)

This area of about 200 acres is from 350 to 600 ft above sea level. It is undeveloped except for a few scattered farms and access should be reasonable with quarry sites readily available.

Mt. Coot-tha Quarry (462325; Map Sheet 4)

The Brisbane City Council is currently working hornfels in a quarry at the foot of the Taylor Range. The crushed rock is used for road-making purposes (including the manufacture of asphaltic concrete), for concrete aggregate, railway ballast and for the construction of ornamental walls, paths, &c.

NERANLEIGH–FERNVALE "GROUP"

The sediments and volcanics of the Neranleigh–Fernvale "Group" cropping out along the north-western boundary of the City have been hornfelsed by the Samford Granodiorite which occurs immediately to the north.

Deposit H 5 (155450; Map Sheet 4)

As with the phyllite, the thickness of this hornfels is undetermined but considerable. This undeveloped area of about 2,200 acres is from 600 to 1,600 ft above sea level. Except for the eastern end of the deposit, it is a State Forest Reserve. Quarry sites are available but access would be difficult.

JOLLY'S LOOKOUT ANDESITES

That part of the Jolly's Lookout andesites which crops out in the City of Brisbane appears at least 100 ft thick and has been recrystallised by the Samford Granodiorite.

Deposit H 6 (080505; Map Sheet 4)

This area of about 12 acres of State Forest Reserve is undeveloped and from 1,400 to 1,600 ft above sea level. Access may be difficult.

XI. LIMESTONE

Cone-in-cone limestone of the Tingalpa Formation crops out at the intersection of Webster and Gympie Roads, Aspley (589569; Map Sheet 5) and was encountered at shallow depth in two auger holes a short distance to the south-west [BMP 23 and BMP 25; Table VIII (17)].

Small lenses of limestone, dolomitic in part, occur in the Petrie and Corinda Formations (Houston, 1967). The thinness and discontinuity of these lenses, together with the depth at which they occur, eliminate any possibility of their commercial exploitation.

XII. METALLIFEROUS

Gold and ores of silver, lead, zinc, manganese and antimony have been found in the Brisbane Metamorphics and the igneous rocks which intrude them but from only one locality, the Finney's Hill Silver-Lead Deposit at Indooroopilly, has there been significant production.

ANTIMONY

A small vein of stibnite and cervantite was found in 1960 at a depth of 8 ft in a sewerage trench at the corner of Milsom and John Streets, *Norman Park* (682303; Map Sheet 3). The mineralised vein was 1 to 2½ in. in width, consisted of ironstained quartz and clay heavily impregnated with cervantite around stibnite and was conformable with the cleavage of the enclosing rocks of the Neranleigh–Fernvale "Group" (Brooks, 1961). This deposit has no economic potential but is of interest in drawing attention to the possibility of finding other deposits in the Brisbane Metamorphics.

GOLD

Sporadic alluvial gold is found in the western and north-western suburbs, the major activity having been along Gold Creek (Map Sheet 4) about 1866; production is insignificant.

In the early nineteen-twenties prospecting for gold reefs was carried out in the rocks of the Neranleigh–Fernvale "Group" or Bunya Phyllite at Carina, Mt. Petrie, East Brisbane, Highgate Hill, Indooroopilly, Taringa, Mt. Coot-tha, Brookfield and between Enoggera and Cedar Creeks in the north-west but the greatest activity, within the limits of the

City of Brisbane, was at Brookfield and Mt. Coot-tha and between Enoggera and Cedar Creeks (Map Sheet 4).

At **Mt. Coot-tha,** where activity continued intermittently from 1893 until the nineteen-fifties, all the workings appear to have been concentrated about 405330 (Map Sheet 4). The gold occurred associated with minor arsenopyrite, chalcopyrite and/or pyrrhotite in irregular pyritic siliceous veins and segregations in foliated hornsfelsed Bunya Phyllite, close to the margin of the Enoggera Granite.

The only recorded production (1940) is of 8·29 cwt of ore which assayed 7 dwt 9 gr. gold, 4 dwt 19 gr. silver and 0·15% copper per ton, and of 66 lb. of ore which assayed 6 dwt 14 gr. gold per ton.

At **Brookfield** the country rocks were irregularly quartz-veined foliated and/or brecciated chloritic schists of the Neranleigh–Fernvale "Group" striking north-west and dipping south-west at 35° to 55° (Morton, 1924). The auriferous reefs occurred filling fissures which were, in general, transverse to the strike of the country rocks and were dislocated by minor faulting. The gold occurred in pyritic quartz generally associated with minor arsenopyrite, galena, sphalerite and chalcopyrite.

Known workings included the *Surprise* (331331; Map Sheet 4), *Eclipse* (320338; Map Sheet 4), *Little Wonder* (308360; Map Sheet 4), *Prince of Wales* (later Acme), *Centenary* and *Dorothy Rita.*

Recorded production from the area is as follows:—

Surprise: 7½ tons ore averaging 1 oz 2 dwt gold per ton;

Eclipse:

6 tons ore averaging 3 oz gold per ton,
5½ tons ore averaging 1 oz 8 dwt per ton,
30 tons ore for a return of 68 oz gold.

On **Enoggera Creek** the *Mt. Aurum* or *Golden Rainbow* workings (292401; Map Sheet 4) were in conformable lenticular quartz reefs containing disseminated pyrite and arsenopyrite (Morton, 1931). No production is recorded.

The *Perseverance* (226458; Map Sheet 4) appears to have been worked intermittently until 1932 but the only detailed report is that of Jack (1897). The gold occurred in a 5 in. west-northwesterly striking quartz reef in foliated quartzite and schist striking north-westerly. The only recorded production (pre-1886) is of 200 tons of ore averaging 6 or 7 dwt of gold per ton.

On **Cedar Creek** the *Double D* workings (293450; Map Sheet 4) were in westerly dipping schist and slate with thin interlaminated quartz (Bunya Phyllite). Gold is said to have occurred in a quartz vein associated with massive pyrite, crystalline arsenopyrite and thin films of sphalerite and galena. No production is recorded.

The auriferous reefs in Brisbane were generally considered by Saint-Smith, Ball and Morton to be magmatic in origin.

MANGANESE

Small quantities of managanese oxides have been obtained in the parish of Kholo, beyond the western limits of the City of Brisbane, but there has been no production from within the City boundaries. Manganese staining and impregnations, too small to be of economic importance, are widespread in jasperoid quartzites of the Neranleigh–Fernvale "Group" north of Moggill, especially about Pullen Pullen Creek. The only known deposit with possible economic potential, however, occupies an area of about 300 sq. yd in por. 48, parish of Moggill (330182; Map Sheet 2), between Pinjarra Street and the Brisbane River, Kenmore. In outcrop a high percentage of siliceous material is evident but further prospecting may be warranted (Cuttler, 1961).

SILVER-LEAD-ZINC

Silver-lead ore was discovered at Finney's Hill, Indooroopilly (448257; Map Sheet 4) by Olsen and Madden in 1918 or 1919, and the discovery was followed by intense prospecting in the Finney's Hill–Taringa–Mt. Coot-tha area. By 1921 the search had extended south to Chelmer, east to Yeronga and Coorparoo and north to Grovely.

At **Yeronga** sporadic pockets of unoxidised galena were found in the Brisbane Tuff but Ball (1920) attributed the occurrence to the presence of mineralised xenoliths of older rocks in the tuff.

The only commercial workings known were those at **Finney's Hill** where production continued from 1919 until 1929 (Table IV).

The various workings of the many individuals and small groups who opened up the area were gradually taken over by companies such as the Indooroopilly Silver-Lead Extended Syndicate, Silver-Lead Ltd., Indooroopilly Silver-Lead Mines N.L., Brisbane Silver-Lead Mine Syndicate and the Finney's Hill United Silver Mines Ltd.

By 1929 the workings comprised a roughly circular open cut with a diameter of about 200 ft at the rim and of about 80 ft at the floor, which was 90 ft below the original surface. Underground working was from three main levels, the 94 ft, 140 ft and the 228 ft, two intermediate levels, the 154 ft and the 175 ft and from at least two shafts. Two exploratory levels were opened but these do not appear to have been worked.

Silver-lead orebodies and argentiferous zinc orebodies were investigated but only the former were worked. They were highly irregular and ill-defined due to minor post-depositional faulting, and occurred in quartz-veined phyllites of the Bunya Phyllite intruded by rhyolite dykes of the Indooroopilly Intrusives.

Quartz-veining in the phyllites was less pronounced in the mine area than elsewhere in that formation and foliation dips were, in general, fairly shallow.

Near the surface the ore was oxidised and carbonates, sulphates, etc. were worked and at depth sulphides occurred interstitially in brecciated phyllites. The presence of associated garnet, arsenopyrite and 0·25 to 0·5% bismuth has been recorded.

Ball (1920a) concluded that the mineralisation was magmatic in origin and deposited in fissures from the extreme differentiates of the igneous source of the rhyolite dykes.

The abandoned mine was acquired by the University of Queensland in 1951 and has been re-opened and developed as a training and experimental mine for students (White, 1958).

TABLE IV

Silver-Lead Production, Finney's Hill, Indooroopilly (after White, 1958)

Year	SILVER ozs	SILVER £ value	LEAD tons	LEAD £ value
1919	10,082	2,604	60.5	2,117
1920	14,410	3,708	90.25	2,449
1921	13,675	2,108	84.75	1,929
1922	13,351	2,003	77.5	1,835
1923	17,834	2,574	129.5	3,566
1924	88,844	13,651	726.0	25,366
1925	46,083	6,366	454.0	16,275
1926	1,567	196	14.0	436
1927	18,712	2,183	137.0	3,343
1928	2,758	310	21.5	432
1929	27	3	1.0	24
Totals	227,343	35,676	1,796.0	58,772

XIII. PETROLEUM

Some interest in petroleum in the City of Brisbane has been shown for a number of years but the search has been unrewarding.

OIL SHALE

Oil shale occurs as small lenses in the Petrie Formation where it was first discovered in wells and bores sunk in the search for underground water. Ball (1945) reported that the lenses were thin and of low-grade; the best of them were about 3 ft in thickness and yielded an average of 35 galls per ton. The maximum known yield from shales of this unit was 50 galls per ton from a sample from the Strathpine area (Figure 1).

OIL AND GAS

Some drilling has been carried out in the City by Mineral Oils and Water Pty. Ltd., Winneills Pty. Ltd., and Standard Gas Pty. Ltd. The eighteen holes which have been drilled to date are listed in Table V.

Shows of oil and gas were reported from several of these holes but minor shows of methane gas only have been confirmed (Geological Survey of Queensland, 1960; Allen and Sanker, 1961; Sanker, 1962, 1963 and 1964).

The entire area of the City of Brisbane is currently held by Phillips Petroleum Co. and Sunray D.X. Oil Co. (under A.P. 71P) and Standard Gas Pty. Ltd. (under P.P.P. 715).

TABLE V

Holes Sunk in the Search for Petroleum

Name	Date	Map Sheet	Grid Reference
Mineral Oils and Water No. 1 (Mt Gravatt)	1939	1	760196
Winneills Pty Ltd Scout No. 1 (Coopers Plains)	1954	1	589102
WPL Scout No. 1 (Bald Hills)	1956–57	5	612740
Standard Gas Scout No. 1 (Cribb Island)	1957–58	5	835609
SG Scout No. 2 (Cribb Island)	1958	5	817621
SG Scout No. 3 (Pinkenba)	1958	3	796475
SG Scout No. 4 (Gumdale)	1958	3	963297
SG Scout No. 5 (Gumdale)	1958	3	897309
SG Scout No. 6 (Gumdale)	1959	3	897309
SG Scout No. 7 (Cribb Island)	1959	5	815619
SG Scout No. 8 (Cribb Island)	1959	5	815619
SG Scout No. 9 (Cribb Island)	1959	5	817621
SG Scout No. 10 (Cribb Island)	1959	5	817621
SG Cribb Island No. 1	1960–63	5	813574
SG Aspley Scout No. 1	1960	5	561615
SG Boondall Scout No. 1	1962	5	695630
SG Cribb Island Scout No. 11	1962	5	817621
SG Sandgate No. 1	1963	5	687703

XIV. QUARTZITE & CHERT

Lenses of quartzite and chert of the Neranleigh-Fernvale "Group" crop out at a number of localities but the size of these bodies could not be determined with the drilling equipment available.

Quartzite occurs at:—

Browns Plains (700952; Map Sheet 1)

Recent work by Mr. R. Beutel has indicated that the bulk of the Neranleigh–Fernvale inlier at the above locality is of quartzite with small lenses of shale intercalated.

Upper Tingalpa (707159; Map Sheet 1)

Between Ford Road and Buhot Creek, south of the line 040N, quartzite and chert occur as loose boulders. The thickness and condition of the underlying quarzite is unknown.

Mt Petrie (818248; Map Sheet 3)

About 818248, at the western end of the Mt Petrie hills, there is a small abandoned quarry with a quartzite face of some 15 ft. The rock is well-jointed in two directions and more material could be obtained if required.

Jointed quartzite and chert and a weakly coherent conglomerate, consisting of cherty boulders in a very fine-grained siliceous cement, were obtained by the Brisbane City Council from two quarries about 873206. These pits are still held by the Council but are rarely worked. The material now obtained is used for the maintenance of road shoulders.

Pine Mountain (741231 and 741224; Map Sheet 3)

The Brisbane City Council and Thiess Bros. Pty. Ltd. currently work quarries at Pine Mountain for broken and jointed quartzite. The major use of this material is for road construction; more weathered material is used as "fill".

Ekibin (632236; Map Sheet 3)

Ekibin Quarry was formerly worked by the City Council and abandoned when the supplies of quartzite were exhausted.

Mt Gravatt (707159; Map Sheet 3)

A small quartzite quarry was formerly worked near the top of Mt Gravatt but its history is unknown. Quantities of quartzite and chert crop out at the summit but this deposit cannot be worked at present as radio relay and other equipment has been installed there.

Mt Ommaney (361160; Map Sheet 2)

Comparatively small lenses of quartzite and chert occur interbedded with basic volcanics to the west of Jindalee in the vicinity of Mt Ommaney.

Some quartzite, together with greywacke and basic volcanics, was obtained from the abandoned quarry at 359173 (Map Sheet 2) [p. 4].

Pullenvale (Map Sheets 2 and 4)

Banded quartzite and chert are common on the higher ridges of the D'Aguilar Range where they form rubbly cappings. In general, these ridges are inaccessible but such material could be exploited in portions 270 and 368, parish of Moggill (212203; Map Sheet 2).

XV. SALINE WATER

Highly saline water was encountered at *Cribb Island* in several holes drilled in the search for petroleum. The aquifer, which is about 40 ft thick, comprises interbedded sand and gravel and was met at about 90 ft. Two samples of this water were analysed at the Government Chemical Laboratory and the results are given in Table VI, where they can be compared with the composition of average sea water.

As the Cribb Island water has about 1·6 times the sodium chloride content of average sea water, testing with a view to the commercial production of salt may be warranted.

Large tracts of undeveloped land occur in the area.

XVI. SAND

Sand is naturally unconsolidated rock material consisting of discrete mineral and/or rock grains, more than 50% of which are from 0·0625 to 2 mm in diameter. Some consist almost entirely of grains of one size or of sizes within the above range but, more commonly, grains of clay size (less than 0·0039 mm), silt size (0·0039 to 0·0625 mm) and/or granule and pebble size (more than 2 mm) occur in varying proportions admixed with the sand size grains (0·0625 to 2 mm) [Pettijohn, 1957, p. 19]. If recognisable percentages of particles of clay, silt, granule or pebble sizes are present in a sand, it is described as clayey, silty, granular or pebbly. Furthermore, depending on the predominant grain size in the sand fraction, sand is described as very fine-grained (0·0625 to 0·125 mm), fine-grained (0·125 to 0·25 mm), medium-grained (0·25 to 0·5 mm), coarse-grained (0·5 to 1 mm) or very coarse-grained (1 to 2 mm). The term "clean" is commonly used to refer to sands which do not contain recognisable proportions of clay or silt particles.

All of the sands described below consist predominantly of siliceous grains and for purposes of description, the following approximate size limits have been assumed:—

Clay and silt ("fines")	grains passing a 200 mesh B.S.S. sieve.
Very fine sand grains	grains passing a 100 mesh and retained on a 200 mesh B.S.S. sieve.
Fine sand grains ..	grains passing a 60 mesh and retained on a 100 mesh B.S.S. sieve.
Medium sand grains	grains passing a 22 mesh and retained on a 60 mesh B.S.S. sieve.
Coarse sand grains ..	grains passing a 10 mesh and retained on a 22 mesh B.S.S. sieve.
Very coarse sand grains	grains passing a 6 mesh and retained on a 10 mesh B.S.S. sieve.
Pebbles	grains retained on a 6 mesh or larger B.S.S. sieve.

TABLE VI
Analyses of Saline Water

		*SG Scout No. 7 (Cribb Island) 120 ft	*SG Scout No. 9 (Cribb Island) 90 ft	**Average Sea Water
pH Value		8.0	8.0	
MILLIGRAMS PER LITRE				
Calcium	as Ca	2,600.	2,400.	400.
Magnesium	as Mg	4,500.	4,600.	1,200.
Sodium	as Na	17,500.	18,000.	10,750.
Alkalinity	as $CaCO_3$	Trace	Trace	100.
Sulphate	as SO_4	3,000.	4,200.	2,600.
Chloride	as Cl	42,500.	42,500.	19,000.
Total Hardness	as $CaCO_3$	25,250.	25,250.	6,000.
Total Dissolved SALTS		70,000.	71,750.	34,000.
Total SOLIDS		85,000.	88,000.	
MILLIEQUIVALENTS PER LITRE				
Calcium	Ca^{++}	130.	120.	20.
Magnesium	Mg^{++}	375.	385.	100.
Sodium	Na^{+}	760.	780.	470.
Bicarbonate	HCO_3'	Trace	Trace	Trace
Sulphate	SO_4''	65.	85.	55.
Chloride	Cl'	1,200.	1,200.	535.
HYPOTHETICAL COMBINATIONS				
Calcium Bicarbonate		Trace	Trace	Trace
Calcium Sulphate		4,400.	5,800.	1,300.
Calcium Chloride		3,600.	1,950.	
Magnesium Sulphate				2,200.
Magnesium Chloride		17,750.	18,250.	3,000.
Sodium Chloride		44,250.	45,750.	27,500.
Total Dissolved SALTS		70,000.	71,750.	34,000.

* Analyses at Government Chemical Laboratory, Brisbane.
** Supplied by M. A. Simmonds, Consulting Analyst and Chemical Engineer, Brisbane.

TABLE VII
* Analyses of Glass Sand, Carole Park

		1	2	3
		Waterford Road	Waterford Road	Glendon Street
Moisture		Nil	Nil	Nil
Loss on ignition		0.10	0.25	0.45
SiO_2		98.90	98.65	97.44
Fe_2O_3		0.10	0.10	0.11
Al_2O_3		0.80	0.90	1.10
MnO		Trace	Trace	Trace
CaO		Trace	Trace	Trace
MgO		Trace	Trace	Trace
Insolubles		0.10	0.10	0.90
Percentage retained on B.S.S. sieve	52	23.8	16.4	43.2
Percentage passing B.S.S. sieve	52	76.2	83.6	56.8
,, ,, ,, ,,	72	76.0	83.4	56.6
,, ,, ,, ,,	85	34.3	38.4	21.7
,, ,, ,, ,,	100	26.5	30.3	15.9
,, ,, ,, ,,	150	15.1	18.2	7.7

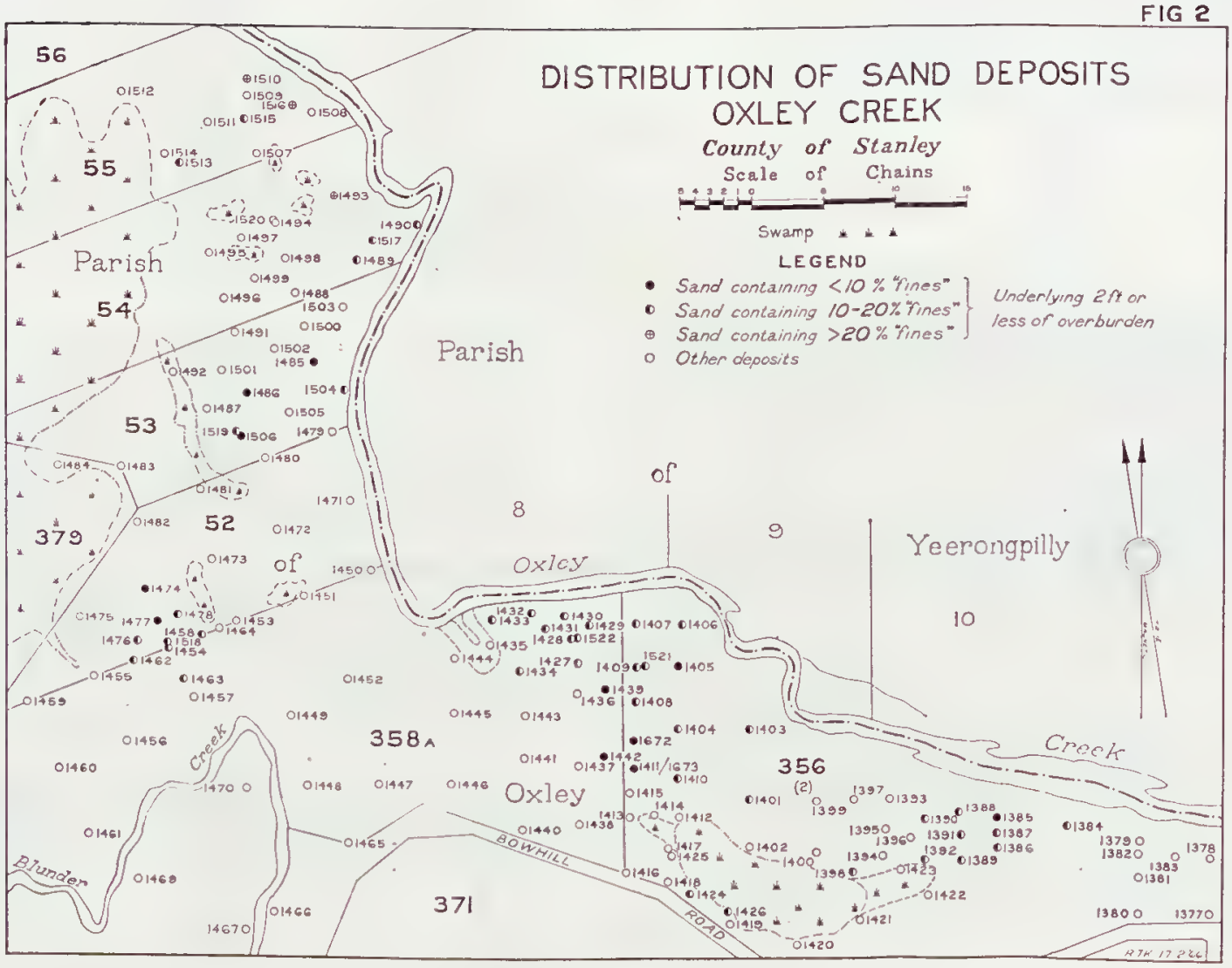
Comments: A portion of each sample was crushed in an agate mortar prior to analysis. The silica was determined by hydrofluoric acid treatment and the insolubles chiefly consist of unattacked zircon.

Organic matter is present in all samples generally in the form of charred grass and carbonised wood.

The total proportion of minerals other than quartz present such as zircon, rutile, clay, tourmaline, hornblende could range up to 2%. These however should present no difficulty in the manufacture of sodium silicate as insolubles such as sodium titanate, sodium zirconate and unattacked minerals should sludge out when the sodium silicates are processed.

* Analyses at Government Chemical Laboratory, Brisbane, 1959.

FIG 2


DISTRICTION OF SAND DEPOSITS
OXLEY CREEK
County of Stanley
Scale of Chains
Swamp
LEGEND
Sand containing <10 % "fines"
Sand containing 10-20% "fines"
Sand containing >20 % "fines"
Underlying 2ft or less of overburden
Other deposits
Parish
Parish
Parish
Oxley
Oxley Creek
Yeerongpilly
Blunder Creek
BOWHILL ROAD
56
55
54
53
52
379
358A
371
356
(2)
8
9
10

Preliminary auger drilling in the City of Brisbane in 1960-61 located a number of small surface sand deposits [Table X (11)] but the only major deposits found were concentrated along Oxley Creek, upstream from its confluence with Blunder Creek.

Oxley Creek Deposits (Figures 2 and 3)

The most promising deposits located on Oxley Creek occurred in the areas bounded by Blunder Creek and Bowhill Road and by Paradise, Brookbent and Gooderham Roads (Map Sheet 1 and Figures 2 and 3).

In 1963-65 closely-spaced auger holes were drilled in these two areas in an endeavour to evaluate the sand deposits in them. As the sand was generally wet and "running" and the auger rig could not be operated in cased holes, no more than an indication of the thickness, quality and extent of the sand was obtained. To obtain more definitive information a representative set of holes was re-drilled using casing and an improvised bailer, similar to those on percussion rigs. From these bailer holes samples were taken for mechanical analysis. By comparison with the samples analysed, the percentage grain size of the sands in the deposits can be estimated.

In the areas tested in detail sand, loam, clay, hard siltstone and decomposed sandstone were encountered.

The *loam*, in general, has economic potential for use in foundations, as "brickie's loam" and as "fill". No attempt has been made to show the distribution of the loam on the accompanying Figures 2 and 3 as similar material occurs along almost the entire length of Oxley Creek, upstream of its confluence with Blunder Creek.

The *clay* has little potential value as it is, in general, unsuitable for use in the ceramic industry or for foundations. Furthermore, the deposits are very small compared with others of higher quality occurring elsewhere in the City. Some of the very sandy clays appear to be suitable for use as "moulding sand".

The *siltstone* and decomposed *sandstone* have no commercial value but could be used as "fill".

It has been found impossible to distinguish between workable and non-workable deposits of sand or to estimate reserves, as the workability of deposits such as these, which contain a wide variety of sands, is dependent on demand for each particular variety. All of these deposits however, have a certain potential value as so little surface sand occurs in the City. The deposits located in the drillholes have been subdivided into four groups, irrespective of whether the sands are fine-, medium- or coarse-grained:—

Type A—sands containing less than 10% "fines"
Type B—sands containing 10 to 20% "fines"
Type C—sands containing more than 20% "fines"
} underlying 2 ft or less overburden.
Type D—other deposits

As the loam which occurs at the surface over the greater part of these areas could generally be exploited commercially, the materials referred to as overburden are restricted to clay, siltstone and sandstone.

The deposits classed as Type D include:—

(*a*) Sand of Types A, B and/or C overlain by more than 2 ft of overburden, excluding those sandy clays which may be suitable for use as "moulding sand".

(*b*) Sand of Types A, B and/or C overlain by more than 2 ft of very sandy clay believed to be suitable for use as "moulding sand".

(*c*) Sandy clay, silty clay or plastic clay, of no apparent commercial value, occurring at the surface or underlying loam and not underlain by sand of any type.

The exploitation of the sand in deposits of Type D does not appear to be an economic proposition except where a market can be established for the overlying materials.

The results of the testing carried out in these areas are detailed in Tables X and XI and briefly summarised below. The distribution of deposits of the four types is shown on Figures 2 and 3; where sand of one type (say A) underlies a significant thickness (about 3 ft or more) of sand of another type (say B), the drillhole is indicated on the figures with the appropriate symbol to signify the upper sand.

Portions 52–55, Parish of Oxley: Fifty drillholes (BMP 1471–1520), including four bailer holes, were sunk approximately 5 chains apart [Table X (1)] and 19 samples were taken for mechanical analysis [Table XI (1–19)].

The distribution of sand deposits of Types A, B and C and of deposits of Type D is shown on Figure 2.

Five auger holes (Type A) intersected from 3 to 13 ft of fine-, medium- and/or coarse-grained, buff sands underlying from 12 to 15 ft of loam. These sands are estimated to contain less than 10% "fines". Seven auger holes (Type B) intersected from 4 to 15 ft of grey, red or buff, very fine- to medium- and/or coarse-grained, slightly silty to very silty or clayey sands underlying 10 to 14 ft of loam and these sands are estimated to contain 8 to 15% "fines". Three auger holes (Type C) intersected 3 to 9 ft of brown or yellow, fine-grained, silty or clayey sands estimated to contain more than 20% "fines".

In general, the fine- and very fine-grained sands are estimated to contain 10 to 20% very fine sand grains, 15 to 35% fine sand grains and 15 to 30% medium sand grains; similarly the fine- to medium-grained sands are estimated to contain 5 to 15% very fine sand grains, 10 to 30% fine sand grains, 50 to 70% medium sand grains and 5 to 20% coarse sand grains and the medium- to coarse-grained and coarse-grained sands 5 to 25% fine sand grains, 30 to 70% medium sand grains and 5 to 40% coarse sand grains.

The remaining 31 auger holes (Type D) intersected from 3 to 20 ft of plastic and/or sandy clay, of no apparent commercial value, at the surface or underlying up to 17 ft of loam. In general, the clay is underlain by 3 to 20 ft of sand similar to the types described above.

The property is owned by J. C. Hutton Pty. Ltd. who utilise it as holding paddocks for stock for the company's nearby meatworks. No sand, loam, etc. has been removed from the property.

Portion 358A, Parish of Oxley: Forty-five drillholes (BMP 1427–1470 and BMP 1522), including one bailer hole, were sunk approximately 5 chains apart [Table X (2)] and one sample was taken for mechanical analysis. Samples taken from BMP 1518 (portion 52) and BMP 1521 and BMP 1673 (sub 2 of portion 356) are also representative of the sands in this area [Table XI (20), (13–15) and (21, 22)].

The distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 2.

Eight auger holes (Type B), in the north-eastern part of the property, intersected 7 to 15 ft of grey, dominantly coarse-grained, sands estimated to contain 10 to 20% "fines", 5 to 15% fine sand grains, 45 to 65% medium sand grains and 10 to 20% coarse sand grains, underlying 0 to 17 ft of loam. In five of these holes (BMP 1429–1431, BMP 1433 and BMP 1434) 2 to 7 ft of buff to yellow, very fine- to medium-grained sands, which are estimated to contain 10 to 20% "fines", underlay the loam and overlay the coarse-grained sands.

BMP 1439 and BMP 1442 (Type A) passed through 13 to 14 ft of loam into 8 ft of buff, fine- to medium-grained sands which are estimated to contain less than 10% "fines" and about 75% medium sand grains and then into coarse-grained, grey sands similar to those described above.

Four auger holes (Type B), near the boundary of portion 52, passed from loam into fine- to medium-grained, slightly clayey, yellow sands estimated to contain 10 to 20% "fines", 10 to 20% fine sand grains and 50 to 70% medium sand grains.

The remaining 30 auger holes (Type D) intersected 8 to 20 ft of plastic or silty clay at the surface or underlying soil and/or loam. In a few holes, sands, similar to those described above, underlay the clay. This clay has no apparent commercial value but does appear to be continuous, in part, with clay deposit Cl 4.

The property is owned by Mr. S. Sharpe who has permitted the removal of small quantities of loam under contract.

Sub 2 of Portion 356, Parish of Oxley: Fifty-three drillholes (BMP 1377–1426, BMP 1521 and BMP 1673), including two bailer holes, were sunk [Table X (3)] and two samples were taken for mechanical analysis [Table XI (21–22)].

The distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 2.

Nineteen of the auger holes (Type B) intersected from 3 to 22 ft of grey to buff to brown, fine- to medium-grained, silty sands and grey, medium- to coarse-grained silty and/or pebbly sands underlying from 5 to 18 ft of loam. These sands are estimated to contain about 10% "fines" and about 60% medium sand grains. Four holes (Type A) intersected from 3 to 13 ft of fine- to medium-grained or coarse-grained sands without recognisable silt content and these are estimated to contain less than 10% "fines" and 70 to 80% medium sand grains.

The remaining 28 auger holes (Type D) intersected from 4 to 20 ft of plastic silty clay, of no apparent commercial value, at the surface or underlying loam. In many of these holes sands, similar to those described above, were met below the clay.

The property is owned by Mr. R. W. Beutel, who currently works a number of loam pits there.

Portion 283, Parish of Oxley: Fifty drillholes (BMP 1766–1813, BMP 1896 and BMP 1897), including two bailer holes, were sunk approximately 2·5 chains apart [Table X (4)] and four sand samples were taken for mechanical analysis [Table XI (23–26)].

The distribution of sand deposits of Types A, B and C and of deposits of Type D is shown on Figure 3.

Eight of the auger holes (Type A) intersected from 3 to 18 ft of fine- to medium-grained, clean to slightly clayey sands at the surface or underlying 5 to 8 ft of loam. These sands are estimated to contain 3 to 6% "fines", 10 to 15% fine sand grains and 55 to 65% medium sand grains. Two auger holes (Type B) intersected 8 ft of very fine- to fine-grained, slightly clayey to clayey sands underlying loam; these sands are estimated to contain more than 10% "fines", 45 to 55% very fine and fine sand grains and up to 35% medium sand grains.

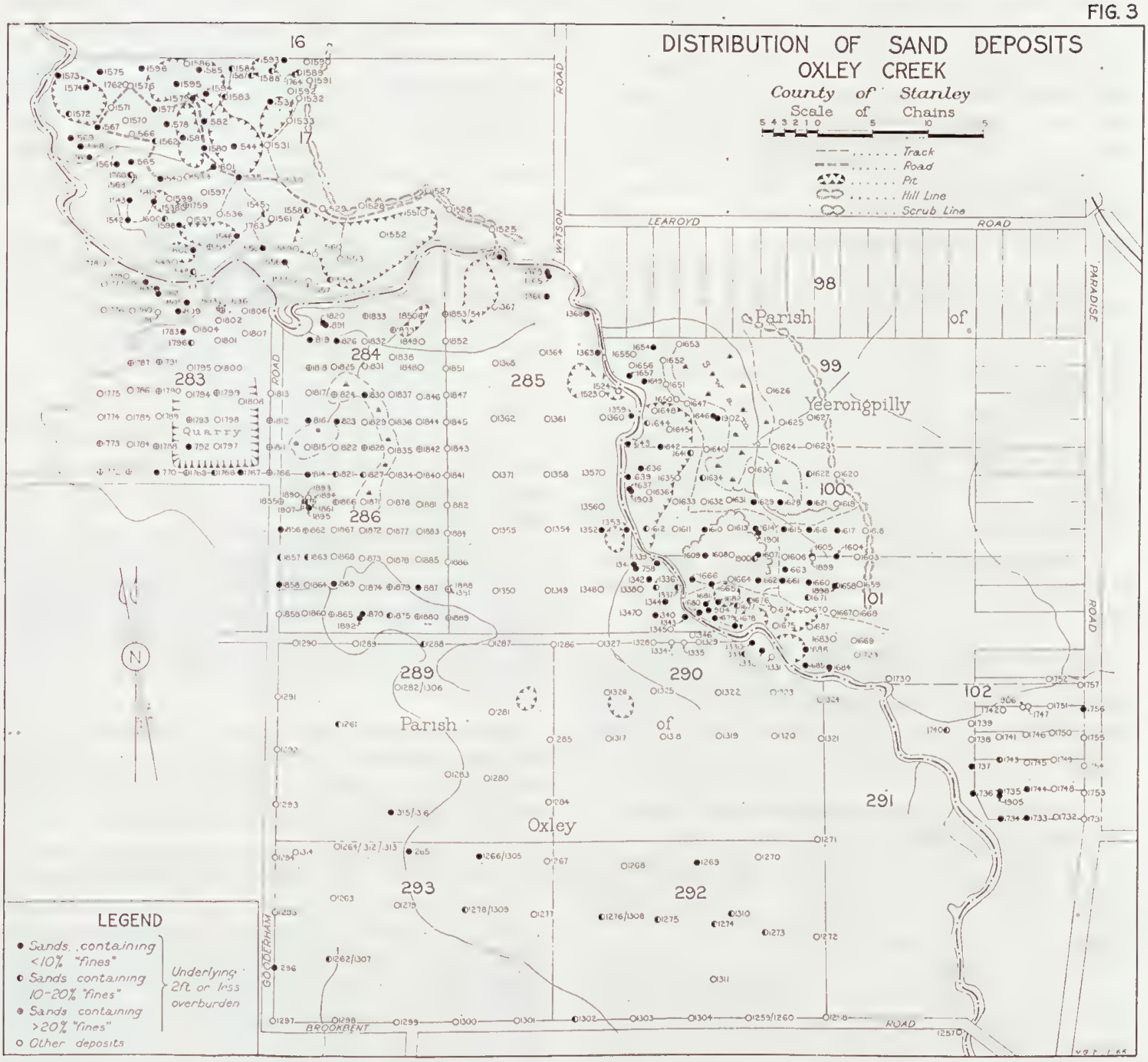
Fourteen auger holes (Type C) intersected very clayey sand, fine-grained clayey to very clayey sand or intercalated very clayey sand and sandy clay at the surface or underlying loam. These sands are estimated to contain more than 20% "fines" and are underlain, in a few holes, by sands similar to those described above (Types A and B).

Twenty-four holes (Type D) intersected more than 2 ft of clay or silty clay, of no apparent commercial value, at or near the surface and commonly overlying sands similar to those described above.

The property was formerly owned by Mr. G. Byrne who has worked pits there for loam, sand and "fill" and has recently been acquired by Kleinschmidt Bros. Pty. Ltd.

Portions 284 and 286, Parish of Oxley: Eighty-three drillholes (BMP 1814–1895 and BMP 1907), including three bailer holes, were sunk approximately 2·5 chains apart [Table X (5)] and eleven samples were taken for mechanical analysis [Table XI (27–37)].

FIG. 3


DISTRICTION OF SAND DEPOSITS
OXLEY CREEK
County of Stanley
Scale of Chains
5 4 3 2 1 0 5 10 5
Track
Road
Pit
Hill Line
Scrub Line
LEAROYD ROAD
WATSON ROAD
PARADISE ROAD
Parish of
Yeerongpilly
Parish of
Oxley
Quarry
16
17
98
99
100
101
102
283
284
285
286
289
290
291
292
293
N
LEGEND
Sands containing <10% "fines"
Sands containing 10-20% "fines"
Sands containing >20% "fines"
Other deposits
Underlying 2ft or less overburden
GODDERHAM
BROOKFIELD ROAD

The distribution of sand deposits of Types A, B, and C and of deposits of Type D is shown on Figure 3.

Almost all of the holes drilled passed through loam, from 3 to 20 ft (dominantly 7 to 10 ft) thick, at the surface. Thirteen of the auger holes (Type A) passed through the loam into 3 to 20 ft of coarse- and medium- to coarse-grained, clean to slightly clayey sands estimated to contain about 1 to 6% "fines". Six of the auger holes (Type B) passed into 4 to 12 ft of fine- and fine- to medium-grained, slightly clayey to clean or slightly clayey to clayey sands estimated to contain 9 to 15% "fines". In general, the fine-grained sands are estimated to contain about 40% fine sand grains and 20% medium sand grains, the fine- to medium-grained sands 20 to 30% fine sand grains and 40 to 50% medium sand grains and the medium- to coarse-grained sands 20 to 60% medium sand grains and 20 to 70% coarse sand grains.

Nineteen of the auger holes (Type C) penetrated more than 2 ft of clayey to very clayey sand and/or sandy clay containing, overall, more than 20% "fines". In general, these materials, some of which should be suitable for use as "moulding sand", are underlain by sands similar to those described above.

The remaining 42 auger holes (Type D) penetrated more than 2 ft of clay, of no apparent commercial value, overlying sands similar to those described above or passed direct from loam into thick clay sections.

The property is owned by Mr. W. Baker who formerly worked a small sandpit in the north-eastern corner near Oxley Creek.

PORTIONS 285 AND 290, PARISH OF OXLEY: Fifty-nine drillholes (BMP 1317–1371, BMP 1523, BMP 1524, BMP 1758 and BMP 1765), including three bailer holes, were sunk approximately 5 chains apart [Table X (6)] and 17 samples were taken for mechanical analysis [Table XI (38–54)].

Distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 3.

The sand deposits of this area fall naturally into two groups—those along the bank of Oxley Creek in the northern part of the area and those in the south-eastern corner of portion 285.

In the northern part of the property six auger holes (Type A) intersected 5 to 15 ft of loam and/or soil overlying 9 to 16 ft of sands estimated to contain less than 10% "fines" and 55 to 70% medium sand grains. The medium- and fine- to medium-grained sands are estimated to contain 15 to 30% fine sand grains and less than 5% coarse sand grains and the coarse- and medium- to coarse-grained sands are estimated to contain less than 10% fine sand grains and 15 to 25% coarse sand grains.

Six to 10 ft of similar sands were met in BMP 1361, BMP 1367 and BMP 1524 (Type D) underlying 18 and 14 ft of soil and clay and 7 ft of sandstone respectively.

In the south-eastern corner of portion 285, 10 auger holes (Type A) intersected 0 to 18 ft of loam overlying 7 to 31 ft of sands estimated to contain less than 10% "fines". Of these, the fine-grained sands should contain close to 10% "fines", 15 to 20% very fine sand grains, 35 to 50% fine sand grains and 25 to 35% medium sand grains, the fine- to medium-grained sands up to 15% very fine sand grains, 10 to 30% fine sand grains, 50 to 80% medium sand grains and up to 20% coarse grains and the coarse-grained or fine- or medium- to coarse-grained sands less than 5% very fine sand grains, 5 to 20% fine sand grains, 35 to 75% medium sand grains and 10 to 30% coarse grains. BMP 1333, BMP 1336 and BMP 1337 (Type B) intersected respectively 3, 4 and 13 ft of fine-grained clayey sands estimated to contain slightly more than 10% "fines" overlying clay and/or sands similar to those described above.

Of the remaining 34 auger holes (Type D), nine (BMP 1329, BMP 1331, BMP 1335, BMP 1338, BMP 1345, BMP 1347, BMP 1348, BMP 1351 and BMP 1354) intersected 3 to 28 ft of sands, similar to those described from the south-eastern corner of portion 285, underlying 5 to 10 ft of clay, of no apparent commercial value, associated with 0 to 11 ft of loam and/or soil.

The remainder of the auger holes intersected 11 to 30 ft of silty, sandy and/or plastic clay and, in a few holes, interbedded sandstone but no sand was encountered.

Portion 285 is owned by H. J. Lee & Son Pty. Ltd. who have opened a number of small sand and loam pits there. Portion 290 has recently been acquired by the Department of the Army and is no longer available for working. A small loam pit near the north-western corner was formerly worked by H. J. Lee & Son Pty. Ltd.

PORTIONS 289, 292 AND 293, PARISH OF OXLEY: Fifty-nine drillholes (BMP 1258–1316), including nine bailer holes, were sunk approximately 5 chains apart [Table X (7)] and 16 samples were taken for mechanical analysis [Table XI (55–70)].

The distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 3.

Five of the auger holes (Type A) penetrated 10 to 17 ft of buff to yellow, fine- to medium-grained sands at the surface or underlying 2 ft of very fine-grained sand which may be suitable for use as "plaster sand". Nine of the auger holes (Type B) passed through 2 to 14 ft of very fine-grained or fine-grained clayey sands, which could prove suitable for use as "plaster sand", into 8 to 24 ft of fine- to medium-grained or coarse-grained buff, yellow or grey sands.

The fine- to very fine-grained sands are estimated to contain 10 to 20% "fines", 30 to 50% fine sand grains and 10 to 20% medium sand grains and the fine- to medium-grained sands to contain less than 10% "fines", 15 to 30% fine sand grains and 45 to 65% medium sand grains. Those described as slightly clayey, clayey or containing thin clay bands should, in general, contain 10 to 20% "fines".

Two auger holes of Type D (BMP 1277 and BMP 1280) penetrated 3 and 8 ft respectively of sandy clay which may prove suitable for use as "moulding sand".

The remaining 34 auger holes (Type D) penetrated 3 to 20 ft of silty or plastic clay and/or siltstone, of no apparent commercial value; in about 50% of the holes this was underlain by sands similar to those described above.

Loam, only, has been worked in this area from a pit near the north-eastern corner of portion 289. The property, except for the Gooderham Road frontage, has recently been acquired by the Department of the Army and is no longer available for quarrying purposes.

PORTION 102, PARISH OF YEERONGPILLY: Twenty-nine drillholes (BMP 1731–1757, BMP 1905 and BMP 1906), including two bailer holes, were sunk about 2·5 chains apart [Table X (8)] and six samples were taken for mechanical analysis [Table XI (71–76)].

The distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 3.

From 2 to 10 ft of loam occurs at the surface over the entire area overlying sand, clay, etc.

In seven auger holes (Type A) from 2 to 15 ft of buff, yellow or grey very fine- to medium-grained slightly clayey to clean sands were met underlying loam and they are estimated to contain less than 10% "fines", 15 to 30% fine sand grains and 50 to 70% medium sand grains. In BMP 1740 and BMP 1743 (Type B) 4 ft of fine-grained, clayey and 16 ft of fine- to medium-grained, very clayey sands respectively underlay loam and these sands are estimated to contain more than 10% "fines" and about 15% very fine sand grains.

The remaining 18 auger holes (Type D) met from 5 to 15 ft of sandy and/or plastic clay, of no apparent commercial value, underlying loam. In all except two holes, the clay was underlain by sands similar to those described above.

The property is owned by Mr. C. Campbell; no pits have been worked there.

PORTIONS 99–101, PARISH OF YEERONGPILLY: Ninety-two drillholes (BMP 1603–1671, BMP 1674–1687, BMP 1729, BMP 1730 and BMP 1898–1904), including seven bailer holes, were sunk 5 chains apart where possible [Table X (9)] and 22 samples were taken for mechanical analysis [Table XI (77–98)].

The distribution of sand deposits of Types A and B and of deposits of Type D is shown on Figure 3.

Thirty-five auger holes (Type A) intersected from 5 to 24 ft of dominantly buff or light grey, fine- to medium-grained or medium- to coarse-grained sands, which are estimated to contain less than 10% "fines", at the surface or underlying from 5 to 14 ft of loam. In 12 of these holes from 2 to 14 ft of very clayey sands, estimated to contain 10 to 20% "fines", underlay these clean sands (BMP 1604, BMP 1609, BMP 1610, BMP 1616, BMP 1621, BMP 1629, BMP 1643, BMP 1661, BMP 1662, BMP 1678, BMP 1681, BMP 1682). In BMP 1617, 4 ft of fine-grained, very clayey sand, estimated to contain more than 20% "fines", occurred at the base of the sand section.

Nine auger holes (Type B) intersected 6 to 17 ft of fine-grained, fine- to medium-grained and medium- to coarse-grained, very clayey sands, estimated to contain 10 to 20% "fines", underlying loam.

The following estimations of percentage grain size are made for the sands described above:—

Very fine and fine-grained sands	10–20% very fine sand grains 30–45% fine sand grains 25–45% medium sand grains
Fine- and fine- to medium-grained sands	10–20% very fine sand grains 35–45% fine sand grains 30–40% medium sand grains
Fine- to medium-grained sands	less than 10% very fine sand grains 20–25% fine sand grains 55–70% medium sand grains
Fine- to coarse-grained sands	5–20% very fine sand grains 10–25% fine sand grains 30–60% medium sand grains 5–30% coarse sand grains
Medium- to coarse-grained and coarse-grained sands	less than 10% very fine sand grains 5–20% fine sand grains 30–60% medium sand grains 15–35% coarse sand grains

Nine auger holes (Type D) intersected from 4 to 16 ft of very sandy (fine-grained) or silty plastic clay, believed to be suitable for use as "moulding sand", at or near the surface and underlain, in general, by from 2 to 17 ft of sands similar to those described above (BMP 1631–1633, BMP 1635, BMP 1651, BMP 1655, BMP 1667, BMP 1668 and BMP 1670).

Seven auger holes (Type D) penetrated 15 to 20 ft of clay or clay and sandstone, of no apparent commercial value (BMP 1603, BMP 1620, BMP 1626, BMP 1627, BMP 1636, BMP 1652, BMP 1659).

The remaining 23 auger holes (Type D) passed through from 4 to 12 ft of clay overlying sands similar to those described above.

The properties are owned by Messrs. R. W. Beutel (portions 99 and 100) and C. Campbell (portion 101). Numerous loam pits have been worked in the area.

PORTION 17, PARISH OF YEERONGPILLY: Eighty-four drillholes (BMP 1525–1602 and BMP 1759–1764), including six bailer holes, were sunk at random [Table X (10)] and 21 samples were taken for mechanical analysis [Table XI (99-119)].

The distribution of sand deposits of Types A, B and C and of deposits of Type D is shown on Figure 3.

Thirty-two auger holes (Type A) intersected from 0 to 16 ft of loam and/or soil overlying 4 to 27 ft of sands estimated to contain less than 10% "fines". The fine- and fine- to medium-grained varieties are estimated to contain up to 15% very fine sand grains, 10 to 35% fine sand grains, 40 to 80% medium sand grains and up to 15% coarse grains and the fine- to coarse-grained and medium- to coarse-grained varieties less than 10% very fine sand grains, 10 to 30% fine sand grains, 50 to 70% medium sand grains and 10 to 30% coarse sand grains. Three auger holes (Type B; BMP 1545, BMP 1589 and BMP 1600) passed from loam through 3 to 11 ft of fine- to very fine-grained clayey sands, estimated to contain 10 to 20% "fines", into 5 to 21 ft of sands similar to those of Type A above. In the remaining nine Type B auger holes, from 3 to 24 ft of comparable fine- to very fine-grained sands were met at the surface or underlying up to 10 ft of loam.

In two auger holes (Type C) 6 and 17 ft. of fine-grained, very clayey sands containing more than 20% of "fines" were met and in one of the holes (BMP 1563) the sand was overlain by 10 ft of loam and underlain by 11 ft of sands similar to those described above (Type A).

Fifteen auger holes (Type D) intersected 8 to 15 ft of clay overburden, with minor associated soil and loam, overlying 5 to 17 ft of sands similar to those of Type A above (BMP 1528, BMP 1530, BMP 1531, BMP 1533, BMP 1537, BMP 1538, BMP 1555, BMP 1566, BMP 1570, BMP 1571, BMP 1576, BMP 1586, BMP 1591, BMP 1592, BMP 1597). Eight auger holes (Type D) intersected 5 to 16 ft of overburden overlying 5 to 21 ft of sands similar to those of Type B above (BMP 1526, BMP 1529, BMP 1532, BMP 1536, BMP 1549, BMP 1553, BMP 1590, BMP 1599). BMP 1525 and BMP 1527 each intersected 20 ft of plastic clay of no apparent commercial value and BMP 1551 and BMP 1557 intersected 8 and 20 ft respectively of very sandy clay, which may prove suitable for use as "moulding sand", overlying plastic clay. The remaining five auger holes (Type D) intersected 5 to 14 ft of sandy clay and very clayey sand, which may also prove suitable for use as "moulding sand", overlying 7 to 20 ft of sands similar to those described above.

Analyses of sands typical of those suggested for use as "moulding sand" are given in Table X (99 and 100).

The property is owned by Mrs. G. I. Edwards and a number of loam and sand pits are currently worked there by H. J. Lee & Son Pty. Ltd.

Bulimba Creek Deposits

Comparatively small pockets of limonitic, fine- to medium-grained, slightly clayey to clayey alluvial sands occur at intervals along Bulimba Creek between Cribb Road (Map Sheet 3) and Prebble Street (Map Sheet 1). Some loam occurs associated with the sand and small lenses of sandy clay are commonly interbedded.

Such material was formerly worked in portion 319, parish of Tingalpa (about 805161; Map Sheet 1) and the deposits are described by Saint-Smith (1926).

The Belmont Sand & Gravel Co. works the only sand pit currently operating in the area at about 799200 (Map Sheet 1).

Lindum Deposit

An extensive alluvial sand deposit on a small tributary of Bulimba Creek at Lindum (about 889398; Map Sheet 3) was worked for many years by E. A. Sibley but supplies are believed to be almost exhausted now.

Brisbane River

The major source of sand in the City at present is the bed of the Brisbane River (p. 21).

Minor Occurrences

Sand was intersected in a number of isolated auger holes drilled in the City in 1960-61 and lithologic logs of these holes are given in Table X (11) and in Table VIII (14), (16), (21; BMP 1118) and (27; BMP 567, BMP 628 and BMP 842).

SANDSTONE

Interbedded decomposed sandstone and conglomerate of the Moorooka Formation could readily be crushed and screened to produce sand and gravel. Such material occurs in gravel deposits Gv 1 and Gv 2 (p. 21).

Browns Plains (691968; Map Sheet 1)

About 30 ft of massive, decomposed fine-grained to coarse-grained, feldspathic and siliceous sandstone occurs as a ridge-capping in the area indicated as Deposit Sd 1 on Map Sheet 1. The rock could be readily crushed and screened to produce sand of various grades.

Sunnybank (622071; Map Sheet 1)

Decomposed Tertiary sandstone was formerly worked for sand in an abandoned quarry off Bradman Street, Sunnybank. The deposit, which is by no means exhausted, is of material containing about 70% siliceous, very fine, fine and medium sand grains (dominantly fine sand grains) and about 30% "fines".

GLASS SAND

The only high grade silica sand suitable for use in glassmaking known in the City occurs at Carole Park, along Bullock Head Creek upstream from its confluence with Sandy Creek (Map Sheet 2). Three abandoned pits, containing limited reserves, were located at 400000 and 394002 (Waterford Road) and 395016 (Glendon Road).

Samples from these localities were analysed at the Government Chemical Laboratory in 1959 and the results are given in Table VII.

XVII. TUFF ("PORPHYRY")

Tuff, or "porphyry" as it is called in the building trade, was used extensively as building and kerbing stone until recent years when workable supplies of suitable stone were exhausted. Small blocks and screened crushings have been, and still are to some extent, used in the City for road construction, the manufacture of concrete building blocks and the building of retaining walls and ornamental walls, paths, etc.

The localities from which building stone was obtained include the following:—

KANGAROO POINT (612319; Map Sheet 3): quarry currently worked by the Department of Harbours and Marine.

SPRING HILL (600393; Map Sheet 3): quarry now abandoned and used as a building site.

VALLEY (615383; Map Sheet 3): abandoned quarry in the R.N.A. Exhibition grounds.

HERSTON (595396; Map Sheet 3): abandoned quarry in the Brisbane General Hospital grounds.

O'CONNELLTOWN [WINDSOR] (605418; Map Sheet 3): formerly operated by Bowser & Lever Pty. Ltd. and abandoned due to proximity to Lutwyche Road and suburban dwellings.

WINDSOR (609439; Map Sheet 3): formerly the old Windsor Town Quarry, now a City Council Works depot.

STAFFORD (591485; Map Sheet 3): a large quarry worked latterly by the Brisbane City Council and abandoned due to exhaustion of the workable tuff supplies.

Several other abandoned tuff quarries have been located but little is known of their history:—

AGNEW STREET QUARRY, MORNINGSIDE (692321; Map Sheet 3): believed to have been worked as a source of material for road construction; abandoned when workable tuff supplies were exhausted.

TINGALPA QUARRY (862346; Map Sheet 3): a large quantity of tuff was removed by the Brisbane City Council before abandonment. Fair reserves remain but the decomposition of the tuff and the thickness of overburden would probably render re-opening an uneconomic proposition.

KITCHENER ROAD, CHERMSIDE (582510; Map Sheet 3): a factory has been built on the floor of this abandoned quarry in which no reserves remain.

WALCOTT STREET, ST. LUCIA (552275; Map Sheet 3).

Reserves of tuff in the City are limited as much of the material available is too decomposed for use in construction and the bulk of the material which might have been suitable for quarrying occurs in closely settled City and suburban areas.

Only one potentially workable deposit has been located:—

Deposit Tu 1 (793257; Map Sheet 3)

This deposit is of doubtful value as fresh and decomposed tuff occur interbedded in the total thickness of about 190 ft of tuff intersected in diamond drillhole Brisbane N.S. 15 (Houston, 1967; Appendix III). This material underlies an overburden of about 40 ft of decomposed (clayey) tuff and minor siliceous conglomerate.

The deposit, which is bounded by the Moonie Pipeline, Old Cleveland Road and Bulimba Creek, is in an undeveloped area which is about 25 to 75 ft above sea level.

Tuff is currently worked at the following localities:—

Kangaroo Point Quarry (612319; Map Sheet 3)

This quarry is worked by the Department of Harbours and Marine. About 60 tons per day are removed by barge for use in the construction of training walls along the Brisbane River, small boat harbours and private river walls. Workable reserves are limited.

Webster Road Quarry, Chermside (575520; Map Sheet 3)

Screened crushings are the chief product sold by the operators, Bowser & Lever Pty. Ltd. of Windsor. No information about production and operation could be obtained from the company but reserves are believed to be considerable.

Milne Mountain Quarry, Aspley (553558; Map Sheet 5)

The material in this City Council quarry is of marginal quality. Some "sound" tuff is obtained for use in the construction of less heavily trafficked roads in the area. The weathered material and overburden are used as "fill". Reserves are limited.

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October, 1965.

TABLE VIII

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS

1. Deposit Cl 1, Moggill

Logs by: J. W. Laycock

BMP 726 (Grid Ref. 191092)

0– 3 ft	GRAVEL: pebbles and boulders up to 11 in.
3–18 ft	CLAY: light grey, plastic.
18–21 ft	CLAY: light red, plastic.
21–24 ft	CLAY: blue-grey, plastic.
24–30 ft	CLAY: black, carbonaceous, plastic.

BMP 727 (Grid Ref. 188100)

0– 6 ft	CLAY: blue-grey and red, plastic.
6–15 ft	CLAY: medium grey, plastic.
15–24 ft	SANDSTONE: light grey, fined-grained, decomposed.

BMP 728 (Grid Ref. 197102)

0– 9 ft	SHALE: light grey.
9–15 ft	CLAY: grey and red, plastic.
15–21 ft	CLAY: red, plastic.
21–24 ft	CLAY: medium grey, plastic.

2. Deposit Cl 2, Darra

Logs by: J. W. Laycock

BMP 702 (Grid Ref. 452089)

0– 3 ft	SAND: brown, fine-grained.
3– 6 ft	CLAY: medium brown, plastic.
6–15 ft	SILTSTONE: light grey, hard, feldspathic.
15–21 ft	SILTSTONE: red and grey.
21–30 ft	SHALE: medium brown.

BMP 703 (Grid Ref. 449096)

0–12 ft	CLAY: dark brown, plastic.
12–18 ft	CLAY: light grey, plastic.
18–24 ft	CLAY: light brown, plastic.
24–30 ft	CLAY: dark grey, plastic.

BMP 704 (Grid Ref. 445111)

0–12 ft	CLAY: light grey and red, plastic.
12–18 ft	CLAY: medium brown, plastic.
18–24 ft	CLAY: red-brown, plastic.
24–30 ft	CLAY: medium brown, plastic.

BMP 1243 (Grid Ref. 407070)

0– 3 ft	CLAY: red and grey, plastic.
3– 9 ft	SANDSTONE: grey, medium-grained, decomposed.
9–12 ft	CLAY: medium brown, very sandy.
12–27 ft	CLAY: light to medium brown, plastic.
27–30 ft	SILTSTONE: mustard brown, hard.

Logs by: B. A. Coxhead

BMP 1688 (Grid Ref. 399081)

0– 8 ft	SILT and CLAY: with pebble bands.
8–13 ft	CLAY: buff and brown, sandy.
13–17 ft	SAND and CLAY: heavily ironstained at base.

Remarks: Water (6 ft).

BMP 1689 (Grid Ref. 402076)

0– 2 ft	SOIL: sandy.
2– 5 ft	SANDSTONE: buff, decomposed; numerous quartz pebbles; hard siliceous limonite band at base.

2. Deposit Cl 2, Darra—continued

BMP 1690 (Grid Ref. 406072)

0– 4 ft	SOIL: light brown and fawn, sandy; thin quartz pebble bands.
4–12 ft	CLAY: with bands of quartz and black quartzite pebbles and siliceous limonite nodules; fossil wood 5–8 ft.
12–19 ft	CLAY: light grey and fawn, plastic.

BMP 1691 (Grid Ref. 406072)

0– 4 ft	SOIL: light brown and fawn, sandy.
4–15 ft	CLAY: pebbly; pebbles of milky quartz and black quartzite; few siliceous limonite nodules.
*15–29 ft	CLAY: light grey, plastic; lightly ironstained in part.
*29–32 ft	CLAY: sandy.
*32–36 ft	SAND and CLAY.
*36–44 ft	CLAY: light brown and grey, plastic; sandy 40–44 ft with brilliant yellow earthy limonite streaks.

Remarks: Water (33 ft).

BMP 1692 (Grid Ref. 407071)

0– 4 ft	SOIL: light brown.
* 4–10 ft	CLAY: grey, plastic.
*10–22 ft	CLAY: red, fawn and grey-green, friable grading to red-brown plastic.
22–22+ft	SANDSTONE: ferruginous.

BMP 1693 (Grid Ref. 411072)

0– 1 ft	SOIL: brown, sandy.
1– 8 ft 6 in.	CLAY and SAND: brown to yellow; 6 in. pebble band at base.
* 8 ft 6 in.–19 ft	CLAY: pink-grey to grey, slightly sandy; very sandy 16–19 ft.
19–23 ft	SAND.

BMP 1694 (Grid Ref. 416074)

0– 0+ ft	SOIL: brown, sandy passing (0–3 ft) into
0+–17 ft	SAND, CLAY and SANDSTONE: light brown and yellow, fine-grained.

BMP 1695 (Grid Ref. 419075)

0– 0+ ft	SOIL: grey and dark brown, sandy passing (0–3 ft) into
* 0+–18 ft	CLAY: grey, brown and yellow mottled, slightly sandy to grey, silty; limonitic 6–11 ft.
*18–20 ft	CLAY: bright yellow, silty.
*20–23 ft	CLAY: light grey, silty.
23–29 ft	CLAY and SAND: light grey.

BMP 1696 (Grid Ref. 423077)

* 0– 8 ft	CLAY: dark grey to light brown.
* 8–10 ft	CLAY: light grey; thin siliceous limonite band at base.
*10–20 ft	CLAY: very sandy passing (about 14 ft) into SAND: cream.

BMP 1697 (Grid Ref. 426078)

0– 3 ft	SOIL: light brown, sandy.
3– 6 ft	CLAY: dark grey to fawn, sandy.
* 6–18 ft	CLAY: fawn, plastic.
*18–32 ft	CLAY: grey; siliceous limonite nodules up to ½ in.; thin siliceous limonite band at 18 ft.

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

2. Deposit Cl 2, Darra—continued

BMP 1698 (Grid Ref. 430080)

0– 3 ft	SOIL: dark chocolate, sandy.
3– 6 ft	CLAY: sandy; very hard ferruginous limonite band at base.

BMP 1699 (Grid Ref. 430080)

0– 3 ft	SOIL: dark brown, sandy.
3– 9 ft	CLAY: dark brown, very sandy; hard limonite band at base.

BMP 1700 (Grid Ref. 431080)

0– 3 ft	SOIL: dark brown, sandy.
3– 9 ft	CLAY: brown, red-brown and grey, plastic; nodules of siliceous limonite.

BMP 1701 (Grid Ref. 432082)

0–18 ft	SAND: light cream, slightly clayey.
18–20 ft	SAND: red, clayey.

BMP 1702 (Grid Ref. 436083)

0–11 ft	SAND and CLAY: ironstained.
11–19 ft	SAND: clayey.
19–26 ft	CLAY: very sandy.
26–29 ft	CLAY: light grey, plastic; limonite nodules.

BMP 1703 (Grid Ref. 440084)

0– 3 ft	SOIL: grey, sandy.
* 3–11 ft	CLAY: light grey to fawn, sandy.
*11–32 ft	CLAY: grey, ironstained; bands and nodules of red limonitic clay, 11–20 ft and 20–32 ft.

BMP 1704 (Grid Ref. 430085)

0– 6 ft	LOAM: chocolate, sandy.
6–16 ft	SAND and CLAY: heavily ironstained.
*16–32 ft	CLAY: light grey, plastic; limonite nodules 26–32 ft.

BMP 1705 (Grid Ref. 436088)

0– 3 ft	CLAY: light grey, sandy.
* 3–10 ft	CLAY: plastic, heavily ironstained; nodules of earthy limonite.
*10–23 ft	CLAY: light grey and fawn, plastic.
23–26 ft	SAND: yellow, clayey.

BMP 1706 (Grid Ref. 435092)

0–14 ft	CLAY: light grey to fawn, sandy to silty.
14–17 ft	SANDSTONE: light buff, weathered.

BMP 1707 (Grid Ref. 435093)

0– 3 ft	SOIL: red, clayey.
3–10 ft	SANDSTONE: cream and light fawn, fine-grained.
10–17 ft	CLAY: very sandy.

BMP 1708 (Grid Ref. 430092)

0– 3 ft	SOIL: brown, clayey.
* 3– 8 ft	CLAY: sandy, heavily ironstained.
* 8–29 ft	CLAY: grey to fawn, plastic; few earthy limonite nodules; silty below 26 ft.
29–32 ft	SAND: fawn, fine-grained, clayey.

BMP 1709 (Grid Ref. 427090)

0– 5 ft	SOIL: light grey, silty.
* 5–10 ft	SANDSTONE: light grey to green, fine-grained.
*10–32 ft	CLAY: light yellow-brown and fawn, plastic; rare earthy limonite bands below 16 ft.

2. Deposit Cl 2, Darra—continued

BMP 1710 (Grid Ref. 424089)

0– 2 ft	SOIL: brown, sandy.
* 2–27 ft	CLAY: chocolate to dark fawn, plastic; slightly silty 11–14 ft; ironstained with earthy limonite nodules 14–20 ft.
*27–29 ft	CLAY: dark fawn, plastic, sandy.

BMP 1711 (Grid Ref. 420087)

0– 3 ft	CLAY: brown and red-brown, sandy.
* 3–20 ft	CLAY: brown and red-brown, ferruginous to highly ferruginous, slightly sandy in part.
*20–26 ft	CLAY: light grey and yellow-brown, silty.
*26–30 ft	CLAY: light grey and yellow-brown, sandy; hard yellow limonite band at 30 ft.

BMP 1712 (Grid Ref. 417086)

0– 2 ft	SOIL: grey, sandy.
* 2–14 ft	CLAY: red-brown and grey, slightly silty; heavily ironstained 11–14 ft.
*14–20 ft	CLAY: red-brown and brown, plastic.
*20–27 ft	CLAY: grey-green and olive green, waxy.
*27–38 ft	CLAY: light grey and yellow to buff, plastic.

BMP 1713 (Grid Ref. 413085)

0– 2 ft	SOIL: light brown, very sandy.
2–17 ft	SAND and CLAY: red, heavily ironstained.
17–17+ ft	SANDSTONE: light cream, fine-grained, siliceous.

BMP 1714 (Grid Ref. 409084)

0– 2 ft	SOIL: grey, sandy.
* 2–14 ft	CLAY: sandy, ironstained.
*14–20 ft	SAND: red, clayey.

BMP 1715 (Grid Ref. 406083)

0– 2 ft	SOIL: brown, sandy.
2– 5 ft	SAND: light grey.
5–14 ft	SAND: red, clayey, heavily ironstained.
*14–20 ft	CLAY: very sandy.

BMP 1716 (Grid Ref. 402082)

0– 2 ft	SOIL: yellow-brown, sandy.
2– 5 ft	SAND: buff.
* 5–17 ft	CLAY: light grey and yellow mottled, sandy.

BMP 1717 (Grid Ref. 421085)

0– 4 ft	SOIL: grey, sandy.
4–11 ft	SANDSTONE: yellow and grey, fine-grained, weathered.
*11–16 ft	CLAY: grey, sandy.
*16–29 ft	CLAY: brown to fawn, plastic.

BMP 1718 (Grid Ref. 423081)

0– 2 ft	SOIL: brown, sandy.
2–11 ft	SANDSTONE: grey, weathered; silty in part.
*11–17 ft	CLAY: yellow to fawn, sandy.
*17–32 ft	CLAY: fawn, plastic.

BMP 1719 (Grid Ref. 397084)

0– 2 ft	SOIL: buff, very sandy.
* 2– 8 ft	CLAY: very sandy.
* 8–17 ft	CLAY: silty and sandy.
17–20 ft	SANDSTONE: cream, fine-grained.
Remarks: Water (18 ft).	

BMP 1720 (Grid Ref. 395086)

0– 5 ft	SOIL: grey and brown, sandy.
5–17 ft	CLAY: grey, sandy to very sandy, ironstained.
Remarks: Water (14 ft).	

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

2. Deposit Cl 2, Darra—continued

BMP 1721 (Grid Ref. 393090)

0– 2 ft	SOIL: brown, clayey.
2–17 ft	SAND: light grey and red-brown, clayey; few blebs of yellow limonitic clay.

BMP 1722 (Grid Ref. 391093)

0– 5 ft	CLAY: brown and red-brown, heavily iron-stained; numerous limonitic nodules.
5–11 ft	CLAY: grey, silty.
11–14 ft	SAND: yellow, clayey.

BMP 1723 (Grid Ref. 396091)

0– 5 ft	SOIL: dark brown and grey, clayey and sandy in part.
* 5–29 ft	CLAY: grey to reddish-fawn, plastic; slightly ironstained and few limonite nodules 14–17 ft.

BMP 1724 (Grid Ref. 390096)

0– 2 ft	SOIL: light grey and brown, sandy.
2–17 ft	SAND: light grey, fine- to medium-grained, slightly clayey.

Remarks: Water (5 ft).

BMP 1725 (Grid Ref. 393097)

0– 1 ft	SOIL: brown, sandy.
* 1– 8 ft	CLAY: fawn and dark grey, plastic.
* 8–14 ft	CLAY: red and red-brown, slightly sandy (coarse-grained), ironstained.
*14–22 ft	CLAY: red-brown and yellowish-grey, plastic; occasional coarse quartz sand grains; hard, thin siliceous limonite band 19 ft.
*22–26 ft	CLAY: grey, silty to sandy.
26–29 ft	SAND: yellow, fine-grained, clayey.

Remarks: Water (28 ft); rose to 14 ft.

BMP 1726 (Grid Ref. 408075)

0– 2 ft	SOIL: grey, sandy.
2– 7 ft	SAND: red, ironstained.
* 7–20 ft	CLAY: light grey; sandy 7–9 ft and 19–20 ft.
*20–23 ft	CLAY: buff, sandy.
*23–29 ft	SAND: clayey.

BMP 1727 (Grid Ref. 413077)

0– 5 ft	SOIL: yellow to buff, sandy.
5–14 ft	CLAY: light brown and grey, sandy; gritty 11–14 ft.
*14–20 ft	CLAY: grey and fawn, sandy (fine-grained) to silty.

BMP 1728 (Grid Ref. 438084)

0– 6+ ft	SOIL: light grey, sandy and clayey; hard limonite band at base passing (6–9 ft) into
6+–14 ft	CLAY: sandy, ironstained; numerous limonite nodules 8–11 ft.
*14–29 ft	CLAY: light grey and fawn, sandy grading to buff, silty.

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3. Deposit Cl 3, Rocklea

Logs by: J. W. Laycock

BMP 639 (Grid Ref. 532137)

* 0–30 ft	CLAY: medium brown, plastic.

Remarks: Water (30 ft).

3. Deposit Cl 3, Rocklea—continued

BMP 640 (Grid Ref. 512130)

* 0–12 ft	CLAY: dark grey to black with numerous gypsum crystals.
12–24 ft	CLAY: blue-grey, red, and medium brown with numerous shale fragments.

BMP 641 (Grid Ref. 514123)

0– 9 ft	SANDSTONE: light grey, fine-grained, decomposed.
9–12 ft	CLAY: red and grey, sandy.
12–15 ft	CLAY: light yellow-brown, numerous shale fragments.
15–24 ft	CLAY: red-brown, plastic, very sandy.
24–30 ft	CLAY: light yellow-brown with numerous hard shale nodules.

BMP 999 (Grid Ref. 540127)

0–18 ft	CLAY: red-brown and medium brown, plastic.
18–21 ft	BASALT.

BMP 1000 (Grid Ref. 538130)

0–15 ft	CLAY: medium grey and brown, plastic.
15–27 ft	CLAY: medium brown, plastic.
27–30 ft	BASALT: partly decomposed.

Remarks: Water (30 ft).

BMP 1001 (Grid Ref. 535133)

0–21 ft	CLAY: medium brown, plastic.
21–27 ft	CLAY: white to light brown, highly calcareous.

Remarks: Water (27 ft).

BMP 1002 (Grid Ref. 533136)

0–24 ft	CLAY: medium brown, plastic.
24–30 ft	CLAY: brown-grey and greenish, plastic.

Remarks: Water (24 ft).

BMP 1003 (Grid Ref. 528137)

0–30 ft	CLAY: medium brown, plastic.

BMP 1004 (Grid Ref. 525135)

0– 3 ft	LOAM: dark brown.
3– 9 ft	CLAY: red-brown, plastic.
9–15 ft	CLAY: medium brown, plastic with occasional gypsum crystals up to 1 in.
15–18 ft	CLAY: blue-grey to brown, plastic.
18–30 ft	CLAY: medium brown, plastic.

BMP 1005 (Grid Ref. 521134)

0–12 ft	CLAY: red-brown to medium brown.
12–18 ft	CLAY: blue-grey and brown, plastic.
18–24 ft	CLAY: medium brown, plastic.
24–30 ft	CLAY: greenish with yellow shale fragments.

Remarks: Water (27 ft).

BMP 1006 (Grid Ref. 517133)

0–30 ft	CLAY: medium brown, plastic.

Remarks: Water (30 ft).

BMP 1007 (Grid Ref. 510134)

0–30 ft	CLAY: medium brown, plastic.

Remarks: Water (30 ft).

BMP 1008 (Grid Ref. 535140)

0–30 ft	CLAY: medium brown, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

4. Deposit Cl 4, Oxley

Logs by: J. W. Laycock

BMP 631 (Grid Ref. 542140)

0– 6 ft	CLAY: dark brown, plastic.
6– 9 ft	CLAY: medium brown, sandy.
9–12 ft	CLAY: yellow-brown, very sandy.
*12–27 ft	CLAY: medium to dark brown, red and grey, plastic.
27–30 ft	SAND: brown, fine-grained.

BMP 632 (Grid Ref. 533042)

0–12 ft	CLAY: medium to dark brown, plastic.
*12–21 ft	CLAY: blue-grey and red, plastic.
21–27 ft	CLAY: dark chocolate brown, plastic.
27–30 ft	SAND: grey to brown, fine-grained.

BMP 648 (Grid Ref. 522067)

* 0–18 ft	CLAY: blue-grey to brown, plastic.
18–30 ft	SAND: light grey, medium to coarse-grained; numerous small pebbles in part.

Remarks: Water (24 ft).

BMP 649 (Grid Ref. 535061)

0– 3 ft	SILT: grey to brown.
3–15 ft	CLAY: medium brown, plastic, sandy in part.
15–24 ft	CLAY: blue-grey to medium brown, plastic.
24–30 ft	SAND: medium brown, fine-grained, few small pebbles.

BMP 992 (Grid Ref. 544044)

0–21 ft	CLAY: medium brown, plastic.
21–24 ft	CLAY: medium brown to blue-grey, plastic.
24–33 ft	CLAY: medium brown, plastic.

BMP 995 (Grid Ref. 540060)

0– 9 ft	LOAM: brown.
9–24 ft	CLAY: medium brown, plastic.
24–30 ft	SAND: medium brown, medium- to coarse-grained.
30–36 ft	SAND: grey, medium- to coarse-grained, few pebbles.
36–42 ft	CLAY: grey and brown, plastic, sandy.

Remarks: Water (42 ft).

BMP 996 (Grid Ref. 532061)

0– 6 ft	LOAM: brown.
6–15 ft	CLAY: medium brown and grey, plastic.
15–24 ft	SAND: brown and grey, fine-grained.
24–30 ft	SAND: grey, medium-grained passing into coarse-grained.

Remarks: Water (30 ft).

BMP 997 (Grid Ref. 529064)

0– 6 ft	CLAY: medium brown, plastic.
6–12 ft	CLAY: blue-grey and brown, plastic.
12–15 ft	CLAY: light grey and red, plastic.
15–18 ft	CLAY: red-brown, plastic.
18–21 ft	CLAY: red-brown to medium brown, plastic.
21–24 ft	CLAY: brown, very sandy.
24–30 ft	SAND: light grey, fine-grained passing into coarse-grained.

BMP 998 (Grid Ref. 518067)

0–15 ft	CLAY: medium brown, plastic.
15–27 ft	SAND: grey-brown, fine-grained.
27–30 ft	SAND: medium-grained.

Remarks: Water (24 ft).

5. Deposit Cl 5, Acacia Ridge

Logs by: J. W. Laycock

BMP 317 (Grid Ref. 596015)

0– 6 ft	SILTSTONE: grey to red and medium brown.
6–12 ft	CLAY: grey to brown, plastic.
*12–15 ft	CLAY: medium grey, plastic.
15–18 ft	CLAY: medium brown, plastic.
18–24 ft	CLAY: medium grey to brown, plastic.

BMP 318 (Grid Ref. 618044)

0– 9 ft	SANDSTONE: red to brown, medium-grained, decomposed.
9–21 ft	CLAY: light grey to brown, plastic.
*21–27 ft	CLAY: blue-grey to brown, plastic.

BMP 543 (Grid Ref. 609033)

0–12 ft	SILTSTONE: light grey, decomposed.
12–24 ft	SANDSTONE: mustard yellow, medium-grained, decomposed.

BMP 544 (Grid Ref. 599035)

0– 9 ft	SILTSTONE: light grey, fossiliferous.
9–18 ft	CLAY: medium to dark brown, plastic.

BMP 619 (Grid Ref. 600043)

0– 9 ft	SILTSTONE: light grey, micaceous in part.
9–15 ft	SANDSTONE: grey to yellow-brown, fine-grained, decomposed.
15–18 ft	CLAY: brown, very sandy passing into SILTSTONE, red.

BMP 620 (Grid Ref. 588034)

0– 6 ft	CLAY: medium to dark brown, plastic.
6–12 ft	CLAY: red-brown, plastic.
12–15 ft	CLAY: red-brown and green, plastic.
15–24 ft	CLAY: medium brown to green and yellow-green, silty.
24–30 ft	SILTSTONE: blue-green, decomposed.

BMP 621 (Grid Ref. 575036)

0– 9 ft	SILTSTONE: light grey, hard.
9–18 ft	CLAY: grey to brown, numerous white calcareous nodules.
18–30 ft	BASALT: numerous vesicles filled with chalcedonic silica.

BMP 622 (Grid Ref. 583043)

0– 9 ft	CLAY: grey and brown, plastic.
* 9–24 ft	CLAY: red-brown, plastic.

BMP 983 (Grid Ref. 618037)

0– 3 ft	SHALE: light grey, hard.
3–12 ft	SILTSTONE: light grey, hard.
12–21 ft	CLAY: light grey, plastic.
21–24 ft	CLAY: grey, very sandy.

Remarks: Water (24 ft).

BMP 984 (Grid Ref. 618041)

0–12 ft	CLAY: light grey and brown, plastic.
12–15 ft	SHALE: light grey.
15–21 ft	SANDSTONE: grey to brown, fine-grained, decomposed.
21–30 ft	SHALE: grey, soft.

BMP 985 (Grid Ref. 612031)

0–24 ft	CLAY: medium brown, plastic.
24–30 ft	CLAY: dark brown, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

5. Deposit Cl 5, Acacia Ridge—continued

BMP 986 (Grid Ref. 605032)

0– 6 ft	CLAY: dark brown, plastic.
6– 9 ft	CLAY: light grey and red-brown, plastic.
9–21 ft	CLAY: light grey to light brown, plastic.
21–30 ft	SANDSTONE: yellow-brown, medium-grained.

BMP 987 (Grid Ref. 601033)

0–15 ft	SILTSTONE: light grey.
15–18 ft	SILTSTONE: brown, decomposed.
18–24 ft	SANDSTONE: medium brown, fine-grained, decomposed.

BMP 988 (Grid Ref. 594034)

0–12 ft	CLAY: light grey and red plastic.
12–15 ft	CLAY: red-brown, plastic.
15–24 ft	CLAY: medium brown, plastic.
24–30 ft	CLAY: dark grey to greenish.

BMP 989 (Grid Ref. 598030)

0–12 ft	CLAY: light brown to light grey, plastic.
12–24 ft	SANDSTONE: light brown, fine-grained, decomposed.
24–30 ft	SANDSTONE: light grey, fine-grained.

BMP 990 (Grid Ref. 596026)

0–15 ft	CLAY: medium brown, silty in part, plastic.
15–24 ft	SANDSTONE: medium brown, fine-grained.

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6. Deposit Cl 6, Eight Mile Plains

Logs by: J. W. Laycock

BMP 280 (Grid Ref. 732093)

*	0–12 ft	CLAY: light grey to brown, plastic, sandy.
	12–21 ft	SANDSTONE: red, hard, decomposed; numerous ferruginous nodules.

BMP 287 (Grid Ref. 731087)

	0– 3 ft	LOAM: medium brown, sandy.
	3– 6 ft	CLAY: reddish, sandy; numerous small pebbles.
*	6– 9 ft	CLAY: light grey to brown, plastic; few hard red ironstone pebbles.
*	9–12 ft	CLAY: medium brown, plastic.

Remarks: Water (12 ft).

BMP 288 (Grid Ref. 721088)

	0– 0+ ft	LOAM: sandy passing (0–3 ft) into
*	0+– 9 ft	CLAY: grey to brown, plastic.
*	9–18 ft	CLAY: grey to purplish.
*	18–30 ft	CLAY: dark grey to black; light grey in part 24–27 ft; purplish in part 27–30 ft.

BMP 289 (Grid Ref. 721080)

	0– 6 ft	CLAY: red, plastic.
*	6–15 ft	CLAY: red and grey mottled, plastic.
*	15–18 ft	CLAY: greenish, plastic; numerous small chips waxy material and chalcedonic nodules.
*	18–24 ft	CLAY: red-brown, plastic; numerous small waxy chips and chalcedonic nodules.
*	24–33 ft	CLAY: medium brown to greenish, plastic; numerous waxy fragments and a few fragments of less altered BASALT below 27 ft.

6. Deposit Cl 6, Eight Mile Plains—continued

BMP 290 (Grid Ref. 729077)

	0– 0+ ft	SOIL: red-brown passing (0–3 ft) into
	0+– 6 ft	CLAY: grey to medium brown, plastic.
	6– 9 ft	CLAY: greenish-grey to brown, plastic.
	9–18 ft	CLAY: greenish, sandy; few waxy chips 9–12 ft; numerous BASALT chips 12–18 ft.

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7. Deposit Cl 7, Eight Mile Plains

Logs by: J. W. Laycock

BMP 126 (Grid Ref. 791074)

0– 3+ ft	SOIL: red, clayey passing (3–6 ft) into
3+– 6 ft	CLAY: red.
6–12 ft	CLAY: medium brown, plastic.
12–24 ft	CLAY: grey to brown, plastic.

BMP 127 (Grid Ref. 790067)

0– 3 ft	LOAM: brown, sandy.
3– 9 ft	CLAY: blue-grey, plastic.
9–12 ft	CLAY: red-brown, plastic.
12–15 ft	CLAY: white to light grey, sandy.
15–18 ft	CLAY: light brown, plastic.
18–24 ft	CLAY: light red-brown, very sandy (fine-grained).
24–30 ft	SANDSTONE: light grey, fine-grained, decomposed.
30–36 ft	SANDSTONE: light grey, medium-grained, decomposed.
36–39 ft	SANDSTONE: pink, fine- to medium-grained, weathered.

BMP 188 (Grid Ref. 804040)

0–18 ft	CLAY: medium brown, plastic.

BMP 229 (Grid Ref. 791072)

*	0– 6 ft	CLAY: light yellow-brown, plastic.
*	6–21+ ft	CLAY: medium brown, plastic passing (21–24 ft) into
	21+–24 ft	SANDSTONE: light grey, decomposed.
	24–30 ft	SANDSTONE: red, fine- to medium-grained, decomposed.

Remarks: Water (24 ft).

BMP 230 (Grid Ref. 786064)

*	0–12 ft	CLAY: yellow-brown, plastic; sandy near top.
	12–15 ft	CLAY: light grey, very sandy.
	15–18 ft	SANDSTONE: yellow-brown, fine-grained, decomposed.
	18–24 ft	SANDSTONE: grey to brown, fine-grained, decomposed.

Remarks: Water (18 ft).

BMP 232 (Grid Ref. 809039)

*	0– 0+ ft	LOAM: sandy passing (0–3 ft) into
*	0+–15 ft	CLAY: medium brown, plastic; few granules, 9–12 ft.
*	15–18 ft	CLAY: blue-grey to brown, plastic.
*	18–30 ft	CLAY: grey to brown.

BMP 233 (Grid Ref. 794041)

*	0– 6 ft	CLAY: brown to greenish, plastic.
	6–12 ft	BASALT: decomposed.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

7. Deposit Cl 7, Eight Mile Plains—continued

BMP 236 (Grid Ref. 786054)

	0– 3 ft	SILTSTONE: medium brown.
	3– 6 ft	SILTSTONE: light red to light grey to light brown.
	6– 9 ft	SILTSTONE: light brown.
*	9–15 ft	CLAY: medium brown, plastic.; with BASALT pebbles near base.

BMP 238 (Grid Ref. 793054)

*	0– 6 ft	CLAY: dark brown, plastic.
	6– 9 ft	CLAY: grey to brown, plastic.
*	9–12 ft	CLAY: light grey, plastic.
	12–21 ft	CLAY: light grey to light brown, plastic.
*	21–24 ft	CLAY: medium grey to brown, plastic.
	24–30 ft	CLAY: dark grey.

BMP 240 (Grid Ref. 786048)

*	0–12 ft	CLAY: light brown to green, plastic.
*	12–18 ft	CLAY: green to brown, plastic; small granules and few small BASALT pebbles towards base.

BMP 241 (Grid Ref. 786042)

*	0– 3 ft	SOIL: red, clayey.
	3– 9 ft	CLAY: red, plastic.
*	9–15 ft	CLAY: medium brown to green, plastic; few BASALT pebbles towards base.
	15–24 ft	CLAY: medium brown, plastic; numerous small BASALT fragments, becoming larger downwards.

BMP 242 (Grid Ref. 783033)

	0– 3 ft	CLAY: brown, plastic.
	3– 6 ft	CLAY: medium brown, plastic.
*	6–12 ft	CLAY: blue-grey, plastic; numerous small soft white talcose granules towards bottom.
	12–15 ft	CLAY: blue-grey and white, plastic.
*	15–18 ft	CLAY: cream and grey, plastic.
*	18–21 ft	CLAY: blue-grey and red.
*	21–30 ft	CLAY: medium brown, plastic.

BMP 243 (Grid Ref. 782024)

	0– 6 ft	SOIL: red, clayey.
	6–12 ft	CLAY: red, sandy; numerous hard red ferruginous sandstone nodules.
*	12–15+ ft	CLAY: red, hard passing (15–18 ft) into
*	15+–18 ft	CLAY: light grey, plastic.
	18–24 ft	CLAY: red and light grey, plastic.
	24–27 ft	CLAY: light grey, plastic.

BMP 244 (Grid Ref. 781017)

	0– 6 ft	CLAY: brownish to grey with few hard BASALT pebbles.
*	6–24 ft	BASALT: decomposed.

BMP 245 (Grid Ref. 780009)

*	0– 6 ft	CLAY: red, plastic.
	6–18 ft	CLAY: red and blue-grey, plastic.
*	18–24 ft	CLAY: medium brown, plastic; becoming greenish and with few BASALT pebbles near bottom.

BMP 246 (Grid Ref. 789011)

*	0–12 ft	CLAY: greenish-brown, plastic; sandy, with numerous BASALT pebbles, 6–12 ft.

7. Deposit Cl 7, Eight Mile Plains—continued

BMP 247 (Grid Ref. 795012)

	0– 6 ft	CLAY: medium brown and green, plastic.
*	6–12 ft	CLAY: medium brown, plastic; sandy, with few QUARTZ and BASALT pebbles.
	12–18 ft	CLAY: light grey to brownish, plastic.
	18–24 ft	CLAY: light grey; few hard red ferruginous nodules.

BMP 249 (Grid Ref. 793031)

*	0– 3 ft	CLAY: brown, plastic; numerous BASALT boulders towards base.

BMP 250 (Grid Ref. 777044)

	0– 3 ft	SOIL: red, clayey.
*	3–12 ft	CLAY: red, numerous granules.
	12–18 ft	CLAY: red-brown.
	18–24 ft	CLAY: red and grey, plastic.
*	24–27 ft	CLAY: light grey and red, plastic.
	27–30 ft	CLAY: light grey, plastic.

BMP 252 (Grid Ref. 760046)

*	0–18 ft	CLAY: brown to greenish, sandy, plastic.
*	18–24 ft	CLAY: greenish, sandy, plastic.

BMP 268 (Grid Ref. 775053)

	0– 6 ft	CLAY: dark brown, plastic.
*	6– 9 ft	CLAY: light red (pink), plastic.
	9–12 ft	CLAY: red-brown, plastic.
	12–18 ft	CLAY: grey-brown, plastic.
*	18–21 ft	CLAY: medium brown, plastic.
	21–27 ft	CLAY: medium brown to grey, plastic.

BMP 269 (Grid Ref. 770064)

*	0–18 ft	CLAY: light grey, plastic.
*	18–21 ft	CLAY: grey to brownish.
	21–24 ft	SANDSTONE: yellow, fine-grained, decomposed; ironstained.

Remarks: Water (24 ft).

BMP 270 (Grid Ref. 780064)

	0– 0+ ft	LOAM: grey, sandy passing (0–3 ft) into
	0+– 6 ft	CLAY: brown, plastic, sandy.
	6– 9 ft	CLAY: light grey, plastic.
*	9–12 ft	CLAY: grey to brown, plastic.
	12–15 ft	CLAY: light red-brown; few hard red ironstone nodules.
	15–18 ft	CLAY: red-brown, plastic.
	18–21 ft	CLAY: light grey, plastic.
*	21–24 ft	CLAY: medium to dark grey, plastic.

Remarks: Water (18 ft).

BMP 271 (Grid Ref. 757062)

*	0– 3 ft	CLAY: grey to brown, plastic.
	3– 6 ft	BASALT: decomposed.

Remarks: Water (6 ft).

BMP 272 (Grid Ref. 755059)

	0– 3 ft	SOIL: medium to dark brown, basaltic.
	3– 9 ft	CLAY: brown to green, plastic.
*	9–27 ft	CLAY: light brown, plastic; numerous granules, 9–15 ft.
*	27–30 ft	CLAY: green, few small (up to 1 in.) fragments of decomposed BASALT.

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

8. Deposit Cl 8, Rochedale

Logs by: J. W. Laycock

BMP 153 (Grid Ref. 858053)

0– 3 ft	CLAY: red to brown.
3– 6 ft	CLAY: white to yellowish.
6– 9 ft	CLAY: white to grey, red in part.
9–24 ft	CLAY: white.
24–24+ ft	CLAY: light brown, plastic passing (24–27 ft) into
24+–30 ft	SILTSTONE: yellow-brown, micaceous.

BMP 154 (Grid Ref. 851063)

0– 3+ ft	SOIL: red, clayey passing (3–6 ft) into
3+– 6 ft	CLAY: red and grey mottled.
6– 9 ft	CLAY: red, sandy in part.
9–12 ft	CLAY: light grey to white.
12–18 ft	CLAY: red, sandy; few quartz granules and small pebbles.
18–21 ft	CLAY: red-brown, plastic.
21–24 ft	CLAY: light grey, plastic.
24–27 ft	CLAY: red-brown and grey, plastic; few ironstained nodules.
27–30 ft	CLAY: light grey to white, plastic.

BMP 156 (Grid Ref. 852057)

0– 3 ft	CLAY: red and grey; very sandy, plastic.
3– 6 ft	CLAY: red, sandy.
6– 6+ ft	CLAY: red passing (6–9 ft) into
6+– 9 ft	CLAY: red and grey mottled.
9–18 ft	CLAY: white to light grey, plastic; few ferruginous nodules.
18–21 ft	CLAY: light grey to brown; few carbonaceous partings.

BMP 157 (Grid Ref. 842055)

0– 6 ft	SANDSTONE: yellow-brown, medium-grained, decomposed.
6–12 ft	SANDSTONE: light grey, decomposed; coarse towards bottom.
12–15 ft	CLAY: grey, plastic.
15–18 ft	CLAY: red; numerous small quartz pebbles.
18–27+ ft	CLAY: blue-grey, plastic passing (27–30 ft) into
27+–30 ft	CLAY: dark grey.

BMP 158 (Grid Ref. 844066)

0– 3 ft	LOAM: red, clayey; few small granules.
3– 6 ft	CLAY: white, ironstained.
6–24 ft	CLAY: white.
24–30 ft	CLAY: white, plastic.

BMP 159 (Grid Ref. 844060)

0– 0+ ft	LOAM: dark grey, sandy passing (0–3 ft) into
0+– 3 ft	CLAY: red-brown.
3– 6 ft	CLAY: light grey, plastic, ironstained.
6–15 ft	CLAY: light grey, soft; plastic towards base.
15–24 ft	CLAY: red and grey mottled, plastic.
24–30 ft	CLAY: blue-grey, plastic.

BMP 219 (Grid Ref. 856054)

*	0– 6 ft	CLAY: dark brown, plastic.
*	6– 9 ft	CLAY: medium brown, plastic.
	9–12 ft	CLAY: yellow-brown, plastic.
*	12–15 ft	CLAY: light brown, plastic.
*	15–24 ft	CLAY: light grey to brown, plastic.

Remarks: Water (18 ft).

8. Deposit Cl 8, Rochedale—continued

BMP 220 (Grid Ref. 852059)

*	0– 6 ft	CLAY: medium brown, plastic.
	6– 9 ft	CLAY: grey to brown, plastic.
*	9–15 ft	CLAY: blue-grey, plastic.
	15–21+ ft	CLAY: light grey, plastic passing (21–24 ft) into
*	21+–24 ft	CLAY: grey to purple, plastic.
	24–30 ft	CLAY: dark brown, plastic.

Remarks: Water (30 ft).

BMP 221 (Grid Ref. 843062)

0– 6 ft	CLAY: red-brown, plastic; fine granules.
*6–24 ft	CLAY: light grey and pink mottled, plastic.

Log by: N. A. H. Simmonds

BMP 827 (Grid Ref. 853053)

0– 3 ft	SOIL: clayey.
3– 9 ft	CLAY: medium brown.
9–15 ft	CLAY: medium brown and white.
15–18 ft	CLAY: olive grey.
18–21 ft	CLAY: grey to white.
21–24 ft	CLAY: grey.
24–27 ft	CLAY: grey and white.
27–30 ft	CLAYSHALE: carbonaceous.

Log by: J. W. Laycock

BMP 832 (Grid Ref. 839055)

0– 3 ft	CLAY: medium brown.
3–12+ ft	SHALE: olive grey passing (12–15 ft) into
12+–15 ft	CLAY: red-brown, fine-grained sandy.

Logs by: N. A. H. Simmonds

BMP 833 (Grid Ref. 850056)

0– 3 ft	SOIL: black.
3– 6 ft	CLAY: red-brown, silty.
6– 9 ft	CLAY: red, plastic.
9–12 ft	CLAY: red and white mottled, plastic.
12–21 ft	CLAY: pink and white mottled, plastic.
21–24 ft	CLAY: brown.
24–30 ft	CLAY: black, plastic; carbonaceous.
30–33 ft	CLAY: brown and grey.
33–36 ft	CLAY: grey, plastic.
36–42 ft	CLAY: brown, plastic.

Remarks: Water (33 ft).

BMP 834 (Grid Ref. 853055)

0– 3 ft	SOIL.
3– 6 ft	CLAY: grey-brown.
6– 9 ft	CLAY: pink
9–12 ft	CLAY: grey, mottled.
12–15 ft	CLAY: medium brown with red patches.
15–18 ft	CLAY: medium brown and black, carbonaceous.
18–21 ft	CLAY: dark brown to black, plastic.
21–24 ft	CLAYSHALE: dark grey to black.
24–30 ft	CLAY: black, plastic.
30–33 ft	CLAY: grey, sandy.
33–42 ft	CLAY: grey, gravelly.

Remarks: Water (30 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

8. Deposit Cl 8, Rochedale—continued

BMP 835 (Grid Ref. 854057)

0– 3 ft	LOAM: clayey.
3– 6 ft	CLAY: light brown, gravelly.
6–12 ft	CLAY: light brown, silty.
12–15 ft	CLAY: dark brown to black; carbonaceous.
15–21 ft	CLAY: light brown, carbonaceous in part.
21–24 ft	CLAY: grey to light brown.
24–27 ft	CLAY: light brown and white.
27–27+ ft	CLAY: medium brown passing (27–30 ft) into
27+–36 ft	CLAYSHALE: light grey, hard.

BMP 836 (Grid Ref. 855060)

0– 3 ft	LOAM: light brown, clayey.
3– 6 ft	CLAY: red-brown, silty.
6– 9 ft	CLAY: light brown, sandy.
9–15 ft	CLAY: light brown to grey, plastic.
15–18 ft	CLAY: light grey to black, plastic; carbonaceous.
18–21 ft	CLAY: black, plastic; carbonaceous.
21–27 ft	CLAY: black to dark brown; carbonaceous.
27–33 ft	CLAYSHALE: light grey with carbonaceous particles and pebbly bands.
33–42 ft	CLAYSHALE: dark grey, carbonaceous; pebbly.

BMP 837 (Grid Ref. 850058)

0– 3 ft	SOIL: light grey.
3– 6+ ft	CLAY: red, plastic passing (6–9 ft) into
6+– 9 ft	CLAY: light grey and red-brown, mottled.
9–15 ft	CLAY: red and grey, mottled.
15–18 ft	CLAY: red-brown, plastic.
18–21 ft	CLAY: dark grey to brown, plastic.
21–24 ft	CLAY: dark brown, plastic.
24–42 ft	CLAYSHALE: black, plastic, carbonaceous; sandy, 30–33 ft and 39–42 ft.

Remarks: Water (24 ft).

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9. Deposit Cl 9, Rochedale

Logs by: J. W. Laycock

BMP 102 (Grid Ref. 876083)

0– 3 ft	CLAY: brown.
3–12 ft	SHALE: light grey, sandy in part; silty in part, 9–12 ft.
12–15 ft	SHALE and SILTSTONE: medium brown.
15–18+ ft	SHALE: medium brown to red passing (18–21 ft) into
18+–21 ft	CLAY: light grey, plastic.
21–24 ft	SANDSTONE: light grey, fine-grained, decomposed.
24–27 ft	SILTSTONE and SHALE: brown, red and black.
27–30 ft	SHALE: black.

BMP 103 (Grid Ref. 887073)

0– 3 ft	SANDSTONE: fine-grained, decomposed.
3– 6+ ft	SANDSTONE: light grey, very fine-grained; clayey when wet passing (6–9 ft) into
6+– 6+ ft	SANDSTONE: yellow and black passing 6–9 ft) into
6+– 9 ft	SHALE: grey to black.
9–18 ft	SHALE: black, sandy in part; carbonaceous in part.
18–21 ft	SILTSTONE: yellow-brown.

9. Deposit Cl 9, Rochedale—continued

BMP 130 (Grid Ref. 896070)

0– 3 ft	CLAY: black, plastic.
3–15 ft	CLAY: blue-grey, plastic.
15–24 ft	CLAY: grey, plastic.
24–27 ft	CLAY: light brown, sandy.
27–33 ft	SHALE: black, carbonaceous.

Remarks: Water (15 ft).

BMP 131 (Grid Ref. 901078)

0– 3 ft	LOAM: sandy.
3– 6 ft	SILTSTONE: light brown to white.
6– 9 ft	SHALE: brown to black, sandy in part.
9–12 ft	SHALE: black.
12–15 ft	SILTSTONE: yellow to brown.
15–18 ft	SHALE: medium brown to yellowish.
18–21 ft	SHALE: medium brown.
21–24 ft	SHALE: black, carbonaceous.

BMP 139 (Grid Ref. 871077)

0– 3 ft	CLAY: brown, plastic.
3– 6 ft	CLAY: red, plastic.
6–18 ft	CLAY: red to grey, plastic; sandy.
18–21 ft	SHALE: brown to black.

BMP 145 (Grid Ref. 875072)

0–12 ft	CLAY: blue-grey, plastic passing (12–15 ft) into
12+–15+ ft	SHALE: light grey, medium hard passing (15–18 ft) into
15+–18 ft	CLAY: blue-grey.
18–21 ft	CLAY: blue-grey, plastic; few small pebbles near bottom.
21–24 ft	CLAY: black, carbonaceous.
24–33 ft	SHALE: black, carbonaceous; few specks of coal, 27–30 ft.

BMP 146 (Grid Ref. 878067)

0– 3 ft	LOAM: brown, sandy.
3– 9+ ft	SANDSTONE: red, medium-grained, decomposed; few small pebbles towards bottom passing (9–12 ft) into
9+–24 ft	CLAY: blue-grey to light grey.
24–27 ft	SILTSTONE: grey to light brown.
27–30 ft	SHALE: medium to dark grey.

BMP 211 (Grid Ref. 873080)

	0– 6 ft	CLAY: medium to dark brown, plastic.
*	6–15 ft	CLAY: red, plastic.
	15–21 ft	CLAY: light grey, plastic.
*	21–24 ft	CLAY: light brown and grey; shaly in part.
	24–30 ft	SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 212 (Grid Ref. 884071)

	0–12 ft	SHALE: light grey to greenish; fairly hard.
*	12–24 ft	SHALE: medium grey, fairly hard; few nodules of fine-grained sandstone, 15–18 ft.

BMP 214 (Grid Ref. 895072)

	0– 6 ft	CLAY: light brown, plastic.
	6– 9 ft	CLAY: blue-grey and red, plastic.
	9–12 ft	CLAY: red, plastic.
*	12–15 ft	CLAY: blue-grey, plastic.
	15–15+ ft	CLAY: brown, plastic, very sandy passing (15–18 ft) into
	15+–18 ft	SANDSTONE: light grey, medium-grained, decomposed.
	*18–24 ft	CLAY: grey, plastic.

Remarks: Water (18 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

9. Deposit Cl 9, Rochedale—continued

BMP 215 (Grid Ref. 899078)

	0– 6 ft	CLAY: medium brown, plastic.
*	6– 6+ ft	CLAY: light brown, plastic, granular passing (6–9 ft) into
*	6+– 9 ft	CLAY: blue-grey, with green waxy granules.
	9–12 ft	CLAY: light grey.
*	12–27+ ft	SHALE: medium brown passing (27–30 ft) into
	27+–30 ft	CLAY: light grey, plastic in part.

BMP 971 (Grid Ref. 885075)

0– 3 ft	CLAY: brown, plastic.
3–12 ft	SILTSTONE: light grey, hard.
12–18 ft	SANDSTONE: fine- to medium-grained, decomposed.
18–24 ft	SANDSTONE: medium- to coarse-grained, decomposed.

BMP 972 (Grid Ref. 882077)

0– 3 ft	CLAY: brown, plastic.
3–12 ft	SILTSTONE: light grey.
12–15+ ft	SHALE: grey to brown, soft passing (15–18 ft) into
15+–18+ ft	SANDSTONE: very fine-grained, decomposed passing (18–21 ft) into
18+–30 ft	SHALE: brown, soft, carbonaceous in part.

BMP 973 (Grid Ref. 879079)

0– 3 ft	CLAY: brown.
3–18 ft	SHALE: light grey, hard; sandy in part, 12–18 ft.
18–24 ft	SHALE: medium brown, soft.
24–30 ft	SHALE: dark brown, soft.

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10. Deposit Cl 10, Upper Tingalpa

Logs by: B. R. Houston

N.S. 6 (Grid Ref. 886072)

	0– 2 ft	CLAY: light red-brown, plastic, ironstained.
	2–14 ft	SHALE: white to light brown, soft.
*	14–17 ft	CLAY: light brown, plastic.
	17–26 ft	SILTSTONE: pinkish-brown; sandy from 20 ft.
	26–29 ft	SANDSTONE: white, fine-grained, clayey.
	29–32 ft	CLAY: medium brown, plastic.
*	32–35 ft	SANDSTONE: white, fine-grained, clayey.
	35–38 ft	CLAY: grey-brown, sandy, plastic.
	38–41 ft	SANDSTONE: light brown, fine- to medium-grained, clayey.
	*41–45 ft 6 in.	CLAY: light brown, plastic; very sandy (fine- to medium-grained).
	45 ft 6 in.–59 ft	SANDSTONE: white to light grey, fine- to medium-grained, argillaceous-siliceous, hard.

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10. Deposit Cl 10, Upper Tingalpa

Logs by: N. A. H. Simmonds

BMP 891 (Grid Ref. 927077)

0– 6 ft	PHYLLITE: decomposed.

BMP 892 (Grid Ref. 931084)

0– 9 ft	CLAY: light brown to light grey, silty.
9–15 ft	PHYLLITE: light grey, unctuous.

BMP 893 (Grid Ref. 935080)

0– 9 ft	CLAY: light brown to light grey, sandy.
9–12 ft	PHYLLITE: decomposed.

Remarks: Water (9 ft.)

10. Deposit Cl 10, Upper Tingalpa—continued

BMP 894 (Grid Ref. 933077)

0– 6+ ft	CLAY: light brown to red-brown and grey, silty passing (6–9 ft) into
6+– 9 ft	PHYLLITE: decomposed.

BMP 895 (Grid Ref. 935088)

0– 3+ ft	CLAY: red-brown, silty passing (3–6 ft) into
3+– 6 ft	PHYLLITE: decomposed.

BMP 896 (Grid Ref. 933090)

0– 3 ft	PHYLLITE: decomposed.

N.S. 8 (Grid Ref. 921084)

0– 2 ft	CLAY: buff, semi-plastic.
2–25 ft	PHYLLITE: light grey to greenish, decomposed; with black bands in part.
25–26 ft	PHYLLITE: fresh, green, silicified.

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11. Deposit Cl 11, Upper Tingalpa

Logs by: J. W. Laycock

BMP 71 (Grid Ref. 946123)

0– 6 ft	CLAY: light grey, plastic.
6– 9 ft	SILTSTONE: light grey, clayey in part.
9–15 ft	SHALE: brown, carbonaceous; clayey in part.
15–18+ ft	SHALE: brown to black, dense; few small plant fragments passing (18–21 ft) into
18+–21 ft	SILTSTONE: light-coloured.

BMP 77 (Grid Ref. 924120)

0– 3 ft	CLAY: brown, very sandy.
3– 9 ft	CLAY: red, sandy.
9–15 ft	CLAY: white to grey, dry; shaly in part, 12–15 ft.
15–21 ft	SHALE: brown, carbonaceous; clayey in part.

BMP 81 (Grid Ref. 905124)

0– 3 ft	CLAY: dark red to brown.
3– 6 ft	CLAY: red to grey mottled.
6– 9 ft	CLAY: light grey to white, plastic.
9– 9+ ft	CLAY: light brown passing (9–12 ft) into
9+–12 ft	SHALE
12–18 ft	SHALE: medium to dark brown, silty.

BMP 199 (Grid Ref. 908119)

* 0– 6 ft	CLAY: light to medium brown, plastic.
* 6–12 ft	SHALE: blue, fairly hard.
*12–15 ft	CLAY: yellow-brown, plastic.
*15–24 ft	SHALE: black, carbonaceous; coaly in part.

BMP 200 (Grid Ref. 925119)

	0– 3 ft	CLAY: light to medium brown; carbonaceous in part.
*	3– 6 ft	CLAY: red, plastic; few granules.
	6–18 ft	CLAY: light grey, plastic.
	18–24 ft	CLAY: red-brown, plastic.
	*24–30 ft	SHALE: medium brown, fairly hard.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

11. Deposit Cl 11, Upper Tingalpa—continued

BMP 201 (Grid Ref. 947124)

*	0– 3 ft	LOAM: sandy.
*	3–21 ft	CLAY: light grey to white, plastic.
	21–24 ft	SHALE: black, coaly in part.
	*24–30 ft	CLAY: medium grey, plastic.

Logs by: N. A. H. Simmonds

BMP 898 (Grid Ref. 918125)

0– 3 ft	SILT.
3– 9 ft	CLAY: blue-grey and red-brown, plastic.
9–15 ft	CLAY: light grey and red-brown, plastic.
15–18 ft	CLAY: light grey, plastic.

BMP 899 (Grid Ref. 933123)

	0– 3 ft	SILT and CLAY: white, yellow-brown.
*	3– 6 ft	CLAY: light brown.
*	6– 9 ft	CLAY: medium brown.
*	9–12 ft	CLAY: dark brown.
*	12–15 ft	CLAY: dark brown, silty.
	15–18 ft	SILT: dark brown, clayey.
	18–21 ft	SILT: red-brown, clayey.

Logs by: J. W. Laycock

BMP 963 (Grid Ref. 924115)

0– 3 ft	CLAY: medium brown, plastic.
3– 6 ft	CLAY: light grey, plastic.
6–12 ft	SILTSTONE: light grey.
12–30 ft	SHALE: medium brown, soft (clayey); fine ironstone granules, 24–27 ft.

BMP 964 (Grid Ref. 923112)

0– 9 ft	CLAY: red-brown, plastic.
9–15 ft	CLAY: light-grey, plastic.
15–27 ft	SHALE: grey to brown, clayey, plastic when wet.
27–30 ft	SHALE: medium grey to brown, harder.

BMP 965 (Grid Ref. 923108)

0– 3 ft	LOAM: red-brown, sandy.
3– 9 ft	CLAY: red-brown, plastic.
9–12 ft	CLAY: light grey and red, plastic.
12–15 ft	CLAY: light grey, plastic.
15–18 ft	CLAY: light to medium brown, plastic; few small pebbles.
18–24 ft	SHALE: dark grey and black; coaly; medium grey in part, 21–24 ft.
24–30 ft	CLAY: light grey and red-brown, plastic.
30–36 ft	SHALE: black, fairly hard; coaly in part.

BMP 966 (Grid Ref. 922105)

0– 3 ft	LOAM: yellow-brown, sandy.
3– 9 ft	CLAY: red, plastic.
9–12 ft	CLAY: light grey, plastic.
12–24 ft	SHALE: light grey, hard.
24–30 ft	CLAY: light grey, plastic.
30–33 ft	SHALE: light grey.
33–36 ft	SHALE: grey to brown, sandy.

BMP 968 (Grid Ref. 917107)

0– 6 ft	LOAM: brown to medium grey, sandy.
6– 9 ft	CLAY: light grey and red, plastic.
9–15 ft	CLAY: light to medium brown, plastic.
15–18 ft	CLAY: light grey, plastic.
18–30 ft	SHALE: medium brown, soft.

Remarks: Water (30 ft).

11. Deposit Cl 11, Upper Tingalpa—continued

BMP 969 (Grid Ref. 915110)

0– 3 ft	CLAY: red-brown, plastic.
3– 6 ft	CLAY: light grey, plastic.
6–18 ft	SHALE: grey to brown, hard in part; fossiliferous.
18–24 ft	SHALE: medium grey, harder.
24–30 ft	SHALE: medium to dark grey, very hard.

BMP 970 (Grid Ref. 913113)

0– 6 ft	CLAY: red-brown, plastic.
6– 9 ft	CLAY: light grey, plastic.
9–24 ft	SHALE: grey to brown, very hard, tuffaceous.

Remarks: Water (24 ft).

Log by: B. R. Houston

N.S. 9 (Grid Ref. 916122)

	0– 5 ft	CLAY: light grey to red-brown, plastic.
*	5–20 ft	CLAY: light grey to yellow, plastic, ironstained.
	20–21 ft	GRAVEL: ironstone, quartz, quartzite in dark red plastic clay.
	21–23 ft	CLAY: light grey and yellow, plastic, laminated.
*	23–29 ft	CLAY: medium grey, plastic, slightly silty.
	29–40 ft	CLAY: light to medium grey, plastic, very sandy.
	40–41 ft	COAL: black, dirty.
	41–55 ft	SHALE: black, with clayey and hard coaly bands.
	55–56 ft	SILTSTONE: hard, black.

Remarks: Seepage at 22 ft.

12. Deposit Cl 12, Rochedale

Logs by: J. W. Laycock

BMP 58 (Grid Ref. 870160)

0– 3 ft	SILTSTONE: light grey, weathered.
3– 6 ft	SILTSTONE: medium brown, dense.
6–12+ ft	SILTSTONE: grey to brown passing (12–15 ft) into
12+–15 ft	SANDSTONE: light grey, medium-grained, decomposed.

BMP 84 (Grid Ref. 876115)

0– 3 ft	CLAY and SHALE: brown.
3– 9 ft	SHALE: medium brown, medium hard.
9–12 ft	SILTSTONE: light brown, micaceous.
12–15 ft	SHALE: brown to black, very carbonaceous.

BMP 86 (Grid Ref. 871128)

0– 6 ft	SILTSTONE: light grey, micaceous.
6–12 ft	SHALE: dark brown, carbonaceous.
12–15 ft	SHALE: dark brown to black.

BMP 87 (Grid Ref. 870143)

0– 3 ft	CLAY: red to brown, very hard.
3– 6 ft	SANDSTONE: light grey, medium-grained, weathered.
6–6+ ft	CLAY: light grey passing (6–9 ft) into
6+– 9 ft	SILTSTONE: light grey.
9–12 ft	SHALE: grey to green, hard.
12–15 ft	SHALE: blue-grey, ironstained in part.

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

12. Deposit Cl 12, Rochedale—continued

BMP 88 (Grid Ref. 861133)

0– 6 ft	SILTSTONE: light grey, weathered, slightly ironstained.
6–12 ft	SHALE: light brown to medium brown; clayey in part.
12–15 ft	SILTSTONE: very weathered, ironstained.

BMP 89 (Grid Ref. 859150)

0– 6 ft	SHALE: light grey to light brown, highly fossiliferous.
6– 9 ft	SILTSTONE: light grey, ironstained.
9–12 ft	SANDSTONE and SILTSTONE: fine-grained, weathered.
12–15 ft	SHALE: medium grey to brownish.

Logs by: I. G. Sanker

BMP 96 (Grid Ref. 857152)

0– 3 ft	CLAY: grey.
3– 6 ft	CLAY: grey, sandy; ironstained.
6– 9 ft	SHALE: grey, slightly sandy.
9–18 ft	SHALE: grey.
18–21 ft	SHALE: grey; some ferruginous sandstone pebbles.
21–24 ft	SHALE: dark grey, very hard; carbonaceous fragments.

BMP 97 (Grid Ref. 830152)

0– 3 ft	CLAY: white.
3–12 ft	SHALE: grey, very hard, with plant fragments.
12–15 ft	SANDSTONE: fine-grained, weathered.
15–18 ft	SANDSTONE: medium-grained.

BMP 98 (Grid Ref. 845140)

0– 9 ft	SANDSTONE: fine-grained, ferruginous.
9–15 ft	SHALE: grey.

BMP 99 (Grid Ref. 858122)

0– 3 ft	CLAY: red, sandy.
3–12 ft	CLAY: white, ironstained.
12–15 ft	SHALE: grey, very hard.
15–24 ft	SHALE: grey to white.
24–27 ft	SHALE: dark grey, carbonaceous.
27–30 ft	SHALE: grey to white and grey.

BMP 100 (Grid Ref. 862110)

0– 0+ ft	CLAY: red and yellow passing (0–3 ft) into
0+– 3 ft	SANDSTONE: decomposed.
3– 6 ft	SANDSTONE: white, fine-grained.
6– 9 ft	SANDSTONE: ferruginous.
9–12 ft	SILTSTONE: white.
12–15 ft	SILTSTONE and SHALE: white.

BMP 106 (Grid Ref. 823157)

0– 3 ft	SOIL and CLAY: yellow, ironstained.
3– 6 ft	SHALE: grey to white, clayey.
6– 9 ft	SHALE: grey to brown.
9–12 ft	SHALE: medium grey.
12–15 ft	SHALE: grey to white.
15–21 ft	SHALE: blue-grey, sandy.
21–24 ft	SANDSTONE: white, decomposed.

BMP 107 (Grid Ref. 825167)

0– 3 ft	SOIL and CLAY: dark grey.
3– 9 ft	CLAY: dark grey.
9–18 ft	CLAY: grey and yellow-brown.
18–21 ft	SHALE: blue-grey.
21–30 ft	SHALE: dark grey, carbonaceous in part.

12. Deposit Cl 12, Rochedale—continued

Logs by: J. W. Laycock

BMP 109 (Grid Ref. 808168)

0– 9 ft	SHALE: medium to dark brown.
9–15 ft	SHALE: dark brown to black.

BMP 111 (Grid Ref. 820148)

0–15 ft	SHALE: medium to dark brown.

BMP 112 (Grid Ref. 818139)

0– 3 ft	SHALE: light brown.
3–12 ft	SHALE: light to medium brown; small ironstone nodules in part 6–9 ft.
12–15 ft	SHALE: blue-grey to medium grey.
15–18 ft	SHALE: medium to dark grey; ferruginous in part.
18–27 ft	SHALE: black, very carbonaceous; brown CLAY in part towards bottom.
27–30 ft	SHALE: grey to black, silty.
30–33 ft	SILTSTONE: grey to cream, clayey in part.
33–42 ft	CLAY: medium grey, plastic.

BMP 113 (Grid Ref. 816131)

0–12 ft	CLAY: grey, plastic; ironstained.
12–15 ft	SILTSTONE: red to brown.
15–21 ft	CLAY: medium grey to brown; plastic; black and shaly in part.
21–24 ft	CLAY: yellow-brown, silty in part.
24–30 ft	SHALE: black; coaly in part near bottom.

BMP 114 (Grid Ref. 814122)

0– 3 ft	CLAY: brown, plastic.
3– 6 ft	CLAY: blue-grey.
6–30 ft	CLAY: white to grey.
30–39 ft	CLAY: black, plastic; silty in part.
39–42 ft	SHALE: light brown; clayey in part.

BMP 115 (Grid Ref. 835120)

0– 3 ft	LOAM: brown, sandy.
3– 6 ft	LOAM: clayey, sandy.
6– 9 ft	CLAY: yellow-brown, ironstained.
9–21 ft	CLAY: light grey to white; ironstained in part.
21–24 ft	CLAY: red, plastic.
24–42 ft	CLAY: red to grey, plastic; slightly sandy to feel, 33–42 ft.

BMP 117 (Grid Ref. 840120)

0– 9 ft	SANDSTONE: red, decomposed.
9–12 ft	CLAY: light grey and red, ironstained.
12–30 ft	CLAY: light grey, plastic.

BMP 124 (Grid Ref. 800117)

0– 6 ft	CLAY: medium brown and grey, plastic.
6– 9+ ft	SILTSTONE: light red, clayey in part passing (9–12 ft) into
9+–12 ft	CLAY: grey, plastic.
12–21 ft	CLAY: white, plastic.
21–24 ft	SHALE: medium to dark brown.
24–30 ft	SHALE: blue-grey.

BMP 174 (Grid Ref. 813106)

0– 3 ft	LOAM: grey to yellow, sandy.
3–12 ft	CLAY: grey to red, fine-grained, very sandy.
12–30 ft	CLAY: light grey, plastic.
30–36 ft	CLAY: dark grey, plastic.
36–42 ft	SANDSTONE: light grey, brown and red: medium-grained, decomposed.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

12. Deposit Cl 12, Rochedale—continued

BMP 175 (Grid Ref. 813116)

0– 0+ ft	LOAM: brown, sandy passing (0–3 ft) into
0+– 6 ft	CLAY: red.
6–12 ft	CLAY: grey to white and red, plastic.
12–15 ft	SANDSTONE: red, hard, ferruginous.
15–18 ft	CLAY: grey to white, plastic.
18–21 ft	SANDSTONE: red, hard, ferruginous.

BMP 196 (Grid Ref. 859152)

	0– 3 ft	CLAY: light grey.
*	3– 6 ft	SHALE: red and brown, fairly hard.
	6–12 ft	CLAY: light grey, plastic.
	12–18 ft	SHALE: medium grey to brown, fairly hard;
*		carbonaceous in part.
	18–21 ft	SHALE: medium grey, fairly soft; carbonaceous in part.
	21–27 ft	SHALE: black, fairly hard; carbonaceous in part.

BMP 197 (Grid Ref. 872140)

*	0– 9 ft	CLAY: medium brown, plastic; silty in part, 6–9 ft.
	9–12 ft	SILTSTONE: red and brown, clayey.
*	12–15+ ft	SHALE: grey, hard; numerous plant fossil fragments in part passing (15–18 ft) into
	15+–18 ft	CLAY: grey.

BMP 204 (Grid Ref. 876115)

	0– 3 ft	CLAY: light brown.
*	3– 6 ft	CLAY: red-brown.
	6–15 ft	CLAY: light grey, plastic.
	15–18 ft	SHALE: brown, fairly hard; carbonaceous in part.
	18–21 ft	SHALE: brown to black, carbonaceous to coaly.
*	21–24 ft	SHALE: black, very coaly.
	24–27 ft	SHALE and CLAY: light grey.
	27–30 ft	CLAY: light grey.

BMP 205 (Grid Ref. 874128)

	0– 3 ft	CLAY: medium brown, plastic.
*	3– 9 ft	CLAY: red-brown, plastic.
	9–15 ft	CLAY: purple-red and grey-red, plastic.
	15–18 ft	CLAY: light grey plastic.

BMP 207 (Grid Ref. 829154)

	0– 6 ft	CLAY: light grey.
*	6–12 ft	SHALE: light to medium brown, fairly hard.
	12–18 ft	SHALE: medium grey to brown.

BMP 208 (Grid Ref. 816169)

	0–12 ft	CLAY: medium brown, plastic.
*	12–15 ft	CLAY: red, plastic.
	15–18 ft	CLAY: light grey, plastic.
*	18–24 ft	CLAY: grey, plastic.
	24–30 ft	CLAY: black, plastic.

Remarks: Water (30 ft).

BMP 209 (Grid Ref. 859124)

	0– 3 ft	CLAY: red-brown.
*	3–12 ft	SHALE: grey to brown, fairly hard.
	12–18 ft	SHALE: red-brown, hard.
	18–24 ft	SHALE: medium brown, soft.
	*24–30 ft	CLAY: grey, plastic.

12. Deposit Cl 12, Rochedale—continued

BMP 223 (Grid Ref. 833121)

	0– 6 ft	SANDSTONE: yellow, fine- to medium-grained, decomposed.
	6–12 ft	SANDSTONE: red to yellow, fine- to medium-grained, decomposed; a few small pebbles.
	12–15 ft	SANDSTONE: light grey to red, very fine-grained; decomposed.
	15–18 ft	CLAY: grey to red, sandy.
*	18–24 ft	CLAY: red, plastic.
	24–27 ft	CLAY: light grey and red, plastic.
	27–30 ft	CLAY: red, plastic.

BMP 224 (Grid Ref. 816127)

	0– 6 ft	CLAY: dark grey to black, plastic.
*	6–12 ft	CLAY: light brown, plastic; greenish in part, 9–12 ft.
	12–15 ft	CLAY: black, plastic; carbonaceous.
	15–21 ft	SHALE: medium brown to grey.
*	21–24 ft	SHALE: light to dark grey, soft.

BMP 225 (Grid Ref. 806107)

	0– 6 ft	CLAY: light grey, plastic.
*	6– 9 ft	SHALE: light brown, fairly soft.
	9–18 ft	SHALE: light grey, soft.
*	18–24 ft	CLAY: grey-brown, plastic.
	24–30 ft	CLAY: medium brown, plastic.

BMP 226 (Grid Ref. 811106)

*	0–12 ft	CLAY: light grey, plastic.
*	12–24 ft	CLAY: medium grey, plastic.
	24–30 ft	SANDSTONE: light grey to reddish, fine-grained; decomposed.

BMP 304 (Grid Ref. 799111)

	0– 0+ ft	LOAM: sandy passing (0–3 ft) into
	0+– 3 ft	CLAY: brownish.
	3– 6 ft	CLAY: grey to brown.
*	6– 9 ft	SHALE: light grey, hard.
	9–12 ft	SHALE: light grey to brown, hard.
	12–18 ft	SHALE: medium brown; hard; few ferruginous nodules.
	18–24 ft	SHALE: dark grey to brown.
	24–30 ft	CLAY: medium brown, plastic.

Logs by: N. A. H. Simmonds

BMP 825 (Grid Ref. 842115)

0– 3 ft	SOIL: light brown, clayey.
3– 6 ft	CLAY: red, plastic.
6–12 ft	CLAY: red and white, mottled.
12–15 ft	CLAY: light grey.
15–21 ft	CLAY: pale red and white mottled; occasional ferruginous pebbles.
21–30 ft	SILTSTONE: light brown, pebbly.

BMP 826 (Grid Ref. 844117)

0– 3 ft	SOIL: red-brown, clayey.
3– 6 ft	CLAY: medium brown; ironstone pebbles; sandy.
6– 9 ft	CLAY: medium brown and white, sandy.
9–15+ ft	CLAY: red and white mottled, sandy passing (15–18 ft) into
15+–18 ft	CLAY: white, plastic.
18–24 ft	CLAY: red and white mottled, plastic.

Remarks: Water (24 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

12. Deposit Cl 12, Rochedale—continued

BMP 905 (Grid Ref. 872150)

0– 3 ft	LOAM and CLAY.
3– 3+ ft	SILTSTONE: hard.

BMP 906 (Grid Ref. 841122)

	0– 3 ft	CLAY: dark grey to light brown, moist.
	3– 6 ft	CLAY: light grey, red and brown, plastic.
*	6– 9 ft	CLAY: yellow-brown, fine sandy, plastic.
	9–12 ft	CLAY: light brown, plastic.
	12–18 ft	CLAY: light grey, plastic.
	18–21+ ft	CLAY: light brown, plastic passing (21–24 ft) into
*	21+–27+ ft	CLAY: medium brown, plastic passing (27–30 ft) into
	27+–30 ft	SHALE: carbonaceous.
	30–33 ft	SHALE: light grey, coaly partings.

BMP 907 (Grid Ref. 840117)

	0– 3 ft	LOAM: brown.
	3–12+ ft	CLAY: red-brown and light grey mottled passing (12–15 ft) into
*	12+–18 ft	CLAY: light brown, nodular; slightly sandy.
	18–24 ft	CLAY: light brown and white; slightly sandy.
	24–30 ft	CLAY: medium brown and light grey; slightly sandy.

BMP 908 (Grid Ref. 840116)

0– 0+ ft	LOAM passing (0–3 ft) into
0+– 3 ft	CLAY: dark red-brown.
3– 6 ft	CLAY: mottled red and white, slightly nodular.
6–12 ft	CLAY: mottled red-brown and white; slightly nodular.
12–15 ft	CLAY: light to medium brown; slightly sandy; hard.
15–18 ft	CLAY: light grey to light brown; slightly sandy.

Logs by: J. W. Laycock

BMP 914 (Grid Ref. 823161)

0– 9 ft	CLAY: red and brown plastic; slightly sandy (medium-grained).
9–12 ft	CLAY: red, plastic.
12–21 ft	CLAY: medium to dark brown; plastic.
21–36 ft	SHALE: medium to dark brown.
36–42 ft	SHALE: dark grey; few carbonaceous plant fragments.

Remarks: Water (42 ft).

BMP 915 (Grid Ref. 824165)

0– 6 ft	CLAY: medium brown to red, plastic.
6–12 ft	CLAY: red and grey, plastic.
12–18 ft	CLAY: medium brown, plastic.
18–21 ft	CLAY: medium to dark brown, plastic.
21–24 ft	CLAY: black, plastic; highly carbonaceous.
24–27 ft	SHALE: carbonaceous.

Remarks: Water (27 ft).

BMP 916 (Grid Ref. 825172)

0– 6 ft	SHALE: grey and brown.
6–30 ft	SHALE: medium brown.

BMP 918 (Grid Ref. 833154)

0–18 ft	SILTSTONE: light to medium grey, micaceous.
18–24 ft	SILTSTONE: medium brown, carbonaceous in part.
24–30 ft	SILTSTONE: medium to dark grey.

12. Deposit Cl 12, Rochedale—continued

BMP 919 (Grid Ref. 835163)

0–18 ft	CLAY: red-brown, plastic.
18–24 ft	CLAY: medium brown, plastic; light grey and white in part.

BMP 920 (Grid Ref. 833158)

0–12 ft	SHALE: light brown to reddish, decomposed; small hard, ferruginous, coarse-grained, SANDSTONE interbed, 6–9 ft.
12–21 ft	SHALE: light to medium brown.
21–42 ft	SHALE: medium to dark brown; silty in part.

Remarks: Water (42 ft.)

BMP 921 (Grid Ref. 837154)

0– 6 ft	SHALE: light grey, hard.
6–18 ft	SHALE: light grey to light brown.
18–24 ft	SHALE: red-brown, soft.
24–33+ ft	SHALE: medium to dark brown, soft passing (33–36 ft) into
33+–36 ft	SHALE: light grey to medium brown, plastic.
36–51 ft	CLAY: dark grey, plastic.

BMP 922 (Grid Ref. 841154)

0– 3 ft	CLAY: red, plastic.
3– 6 ft	CLAY: red and grey, plastic.
6–24 ft	SHALE: light grey.
24–30 ft	CLAY: light grey, plastic.
30–36 ft	SHALE: medium grey to medium brown.

BMP 923 (Grid Ref. 849154)

0–12 ft	SHALE: light grey to light brown; silty in part, 3–6 ft.
12–18 ft	SHALE: medium brown, soft; carbonaceous.
18–21+ ft	SHALE: black, coaly; numerous vitrain fragments passing (21–24 ft) into
21+–24 ft	CLAY: white.
24–30 ft	SHALE: black, coaly; numerous vitrain partings.
30–36 ft	COAL: black, numerous vitrain partings; shaly in part.
36–48 ft	SHALE: dark grey to black; few coal partings.

BMP 924 (Grid Ref. 864145)

0–12 ft	CLAY: light grey, plastic.
12–18 ft	CLAY: red-brown, plastic; few hard ironstone nodules.
18–30 ft	SHALE: medium brown; plastic in part, 18–24 ft; carbonaceous in part, 24–27 ft.
30–36 ft	SHALE: medium to dark grey; few small COAL interbeds.
36–42 ft	SHALE: medium to dark grey, hard.

Remarks: Water (39 ft).

BMP 925 (Grid Ref. 863142)

0– 9 ft	CLAY: grey-brown, plastic.
9–18 ft	SANDSTONE: light grey to brown, fine- to medium-grained.

BMP 926 (Grid Ref. 862138)

0– 6 ft	SILTSTONE: light grey, decomposed.
6–18 ft	SHALE: medium grey to brown, soft; weathered in part.
18–24 ft	SHALE: medium to dark brown, soft.
24–30 ft	SHALE: medium grey; sandy in part.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

12. Deposit Cl 12, Rochedale—continued

BMP 928 (Grid Ref. 866157)

0– 6 ft	CLAY: red, plastic.
6–12 ft	CLAY: light grey, plastic.
12–18 ft	SHALE: light grey, hard.
18–24 ft	SHALE: light brown, soft; carbonaceous in part.
24–30 ft	SHALE: light to medium brown, soft.

BMP 929 (Grid Ref. 866160)

0– 3 ft	CLAY: light grey, plastic.
3–18 ft	SHALE: light grey to light brown, fairly soft.
18–21 ft	SHALE: medium brown, fairly soft.
21–24 ft	SHALE: light grey, fairly soft.
24–30 ft	SHALE: grey to brown, soft.

BMP 930 (Grid Ref. 836147)

0–18 ft	CLAY: red to brown, plastic.
18–21 ft	CLAY: grey to medium brown, plastic.
21–30 ft	SHALE: grey to medium brown, soft.

BMP 931 (Grid Ref. 846135)

0– 9 ft	SHALE: light grey, hard.
9–18 ft	SHALE: light grey to reddish; few hard ironstone bands, 9–12 ft.
18–24 ft	SHALE: grey to brown, fairly soft.
24–30 ft	SHALE: brown, soft.

BMP 932 (Grid Ref. 848133)

0–12 ft	CLAY: red, plastic.
12–18 ft	CLAY: red and light grey, plastic.
18–24 ft	CLAY: white, plastic.
24–36 ft	CLAY: light grey and red, plastic; sandy in part.

BMP 933 (Grid Ref. 854126)

0– 6 ft	CLAY: dark brown, plastic; sandy.
6–18 ft	CLAY: medium brown, light grey in part; soft, plastic when wet.
18–30 ft	CLAY: medium to dark brown, plastic.

BMP 934 (Grid Ref. 866119)

0– 3 ft	SOIL: dark brown.
3– 9 ft	CLAY: red, sandy (fine- to medium-grained); hard.
9–12 ft	CLAY: grey and red, very sandy.
12–24 ft	CLAY: light grey, plastic.
24–27 ft	CLAY: red-brown, sandy (very fine-grained).
27–30 ft	CLAY: medium brown, plastic.

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13. Deposit Cl 13, Mount Gravatt–Belmont

Logs by: J. W. Laycock

BMP 329 (Grid Ref. 770135)

*	0– 9 ft	SHALE: light grey, fairly hard.
*	9–18 ft	SHALE: grey-brown, fairly hard.

BMP 333 (Grid Ref. 780142)

	0– 3 ft	CLAY: red, sandy.
	3– 6 ft	CLAY: red and grey, fine sandy.
*	6–12 ft	CLAY: light grey and red, plastic.
*	12–30 ft	CLAY: light grey, plastic.

13. Deposit Cl 13, Mount Gravatt–Belmont—continued

BMP 335 (Grid Ref. 798155)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 3 ft	SANDSTONE: red.
3– 6 ft	SANDSTONE: red, medium-grained; decomposed.
6– 9+ ft	CONGLOMERATE: red; numerous quartzite pebbles to 1 in. passing (9–12 ft) into
9+–12 ft	SANDSTONE: red, coarse-grained.
12–24 ft	CLAY: light grey; plastic.

BMP 336 (Grid Ref. 781158)

0– 3 ft	LOAM: sandy.
3– 6 ft	SANDSTONE: red, decomposed with few boulders.
6– 9 ft	CLAY: red and blue-grey, plastic.
9–12 ft	CLAY: light grey-brown, plastic.
12–18+ ft	CLAY: light grey, plastic to black, carbonaceous passing (18–21 ft) into
18+–27 ft	SHALE: medium grey, carbonaceous in part (fragments), micaceous.
27–30 ft	SHALE: black.

Remarks: Water (30 ft).

BMP 339 (Grid Ref. 788184)

	0– 0+ ft	SOIL passing (0–3 ft) into
	0+– 3 ft	CLAY: light grey to red; plastic.
	3–12 ft	CLAY: light grey-brown, plastic.
	12–15 ft	SHALE: light to medium brown.
*	15–24 ft	SHALE: medium brown, soft, carbonaceous in part; clayey in part towards bottom.
	24–27 ft	SHALE: dark grey to black; few thin coal partings.
	27–30 ft	SHALE: grey-brown.

BMP 341 (Grid Ref. 798197)

0– 9 ft	SANDSTONE: light grey to red, fine- to medium-grained; decomposed.
9–15 ft	SILTSTONE: light grey.

BMP 349 (Grid Ref. 776222)

0– 9 ft	CLAY: light grey to brown, plastic.
9–18 ft	CLAY: light grey, dry.
18–30 ft	CLAY: red-brown; few quartz pebbles, 21–24 ft; hard in part, 24–27 ft.

BMP 350 (Grid Ref. 777222)

0– 6+ ft	CLAY: red, dry passing (6–9 ft) into
6+– 9 ft	TUFF: white to red.

BMP 351 (Grid Ref. 769223)

	0– 9 ft	CLAY: light grey; soft.
	9–15 ft	SHALE: light grey, hard; few purplish argillaceous nodules.
*	15–24 ft	SHALE: light grey; hard.
	24–30 ft	SHALE: brown to black; hard.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

13. Deposit Cl 13, Mount Gravatt–Belmont—continued

BMP 600 (Grid Ref. 767187)

0– 6 ft	CLAY: red, hard; numerous angular milky quartz pebbles.
*6–15 ft	CLAY: light grey to brown, plastic.
*15–18 ft	SHALE: light brown, sandy.
*18–24 ft	CLAY: white, plastic.
*24–33+ ft	SHALE: black, carbonaceous; few vitrain partings, 24–27 ft; coaly, 30–33 ft passing (33–36 ft) into
33+–36 ft	SILTSTONE: light to medium grey.

Remarks: Water (30 ft).

BMP 601 (Grid Ref. 783167)

* 0–18 ft	SILTSTONE: light grey and red; micaceous in part.
*18–24 ft	SILTSTONE: light grey to light brown, sandy; few ironstone nodules.
*24–30 ft	CLAY: medium brown, plastic.

BMP 602 (Grid Ref. 766160)

0–12 ft	CLAY: blue-grey and red, plastic, sandy.
*12–18 ft	SILTSTONE: light grey to light brown.
*18–24 ft	CLAY: light grey to light green, plastic.
24–27 ft	SANDSTONE: light grey, medium- to coarse-grained; decomposed.

Logs by: N. A. H. Simmonds

BMP 885 (Grid Ref. 790157)

0– 3 ft	LOAM: medium brown, sandy.
3– 6 ft	CLAY: greenish, light to medium grey, sandy, plastic.
6– 9 ft	CLAY: light reddish-brown, sandy, plastic.
9–15 ft	CLAY: pale grey and medium brown mottled, plastic; few ironstone nodules, 12–15 ft.
15–18 ft	CLAY: light brown, plastic; sandy in part, ironstained in part.
18–24 ft	CLAY: medium brown, silty.
24–27 ft	CLAY: light brown and black, silty.
27–30 ft	SHALE: black, carbonaceous.

BMP 887 (Grid Ref. 792183)

0– 3 ft	LOAM and CLAY.
3– 6+ ft	CLAY: pinkish-brown, plastic passing (6–9 ft) into
6+–15+ ft	CLAY: light brown, plastic; few granules, 12–15 ft passing (15–18 ft) into
15+–24 ft	SHALE: light grey.

BMP 888 (Grid Ref. 791169)

0– 3 ft	SILT and CLAY.
3– 9 ft	CLAY: white and pink, non-plastic, dry; few granules, 6–9 ft.
*9–15 ft	SHALE: light brown.
15–21+ ft	CLAY: light red-brown and grey, non-plastic passing (21–24 ft) into
21+–30 ft	SHALE: medium brown.

BMP 889 (Grid Ref. 769216)

0– 3 ft	LOAM: fine, sandy.
3– 6 ft	SILTSTONE: pink.
6– 9 ft	SILTSTONE: light brown.
*9–12 ft	SHALE: light grey; clayey in part.
*12–24 ft	SHALE: light grey and light brown.

Logs by: J. W. Laycock

BMP 935 (Grid Ref. 776138)

0– 3 ft	SOIL.
3– 6 ft	CLAY: deep red, plastic; fairly hard.
6–18 ft	CLAY: light grey to white, plastic.
18–33 ft	CLAY: medium brown to reddish, plastic.
33–36 ft	SANDSTONE: medium brown, fine-grained, decomposed.

13. Deposit Cl 13, Mount Gravatt–Belmont—continued

BMP 936 (Grid Ref. 766134)

0–12 ft	SANDSTONE: light grey, fine-grained, decomposed.
12–24 ft	SHALE: medium grey to brown, soft.
24–24+ ft	SHALE: dark grey to black passing (24–27 ft) into
24+–27 ft	IRONSTONE: very hard.

BMP 938 (Grid Ref. 776150)

0– 6 ft	CLAY: blue-grey and brown, plastic.
6–15 ft	SHALE: light grey, hard.
15–18 ft	CLAY: grey and brown, plastic.
18–24 ft	SHALE: light grey, hard; grey and brown, clayey in part.
24–30 ft	CLAY: medium to dark brown, plastic.

BMP 939 (Grid Ref. 772150)

0– 9 ft	CLAY: medium brown, plastic.
9–12 ft	CLAY: grey to brown, soft.
12–27 ft	CLAY: red to brown, soft.
27–36 ft	SANDSTONE: brown, medium- to coarse-grained, decomposed.

BMP 940 (Grid Ref. 780153)

0– 3 ft	LOAM: medium brown, sandy.
3– 6 ft	CLAY: red, plastic; sandy.
6–15 ft	CLAY: light grey to red, plastic.
15–18 ft	CLAY: light grey to brown, plastic.
18–24 ft	CLAY: light grey, plastic.
24–27 ft	SANDSTONE: light grey, fine- to medium-grained, decomposed.
27–30 ft	SANDSTONE: red, medium-grained, decomposed.

BMP 943 (Grid Ref. 764160)

0– 6 ft	SANDSTONE: light grey, fine-grained, decomposed; red in part, 3–6 ft.
6–18 ft	SHALE: medium brown, soft; highly fossiliferous.
18–30 ft	SANDSTONE: light to medium brown, fine-grained, decomposed.

BMP 944 (Grid Ref. 782161)

0– 9 ft	CLAY: blue-grey and brown, plastic; sandy in part (fine-grained).
9–15 ft	CLAY: medium brown, plastic, sandy; few pebbles (to 1 in.).
15–18 ft	CLAY: light grey, plastic.
18–30 ft	CLAY: medium to dark brown, plastic; numerous small hard shale chips.

BMP 945 (Grid Ref. 783165)

0– 3 ft	SOIL: medium to dark brown.
3– 6 ft	CLAY: dark red, plastic.
6–18 ft	CLAY: light grey and red, plastic.
18–30 ft	CLAY: light to medium brown, plastic.

BMP 946 (Grid Ref. 785171)

0–24 ft	CLAY: red, plastic; blue-grey in part, 12–15 ft.
24–30 ft	CLAY: red and light grey, plastic.

BMP 947 (Grid Ref. 785175)

0– 3 ft	LOAM: grey, sandy.
3– 9 ft	CLAY: light yellow-brown, plastic; slightly sandy (very fine-grained),
9–15 ft	CLAY: light grey and yellow-brown, plastic.
15–29 ft	CLAY: dark brown, plastic; few shale chips, 21–27 ft; numerous shale chips, 27–29 ft.
29–30 ft	SHALE: medium grey, hard.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

13. Deposit Cl 13, Mount Gravatt–Belmont—continued

BMP 948 (Grid Ref. 786178)

0– 9 ft	CLAY: red to brown, plastic.
9–24 ft	CLAY: medium brown, soft; plastic when wet.
24–30 ft	SHALE: medium brown, soft.

BMP 949 (Grid Ref. 783184)

0–18 ft	CLAY: light grey, plastic; numerous ironstone nodules, 15–18 ft.
18–30 ft	SHALE: medium brown, soft.

BMP 950 (Grid Ref. 777185)

0–18 ft	CLAY: red-brown and blue-grey, plastic.
18–30 ft	CLAY: light red-brown, plastic; light grey in part, 27–30 ft.

BMP 951 (Grid Ref. 773186)

0– 6 ft	CLAY: dark brown, fine granules.
6– 9 ft	SILTSTONE: grey to red, decomposed.
9–18 ft	SHALE: medium brown, soft.
18–27 ft	SHALE: light to medium brown, soft.
27–33 ft	SHALE: dark brown to black, soft, carbonaceous; coaly in part, 30–33 ft.
33–36 ft	SHALE: dark grey to black; small COAL seam.
36–42 ft	SHALE: dark grey, very coaly.

BMP 952 (Grid Ref. 769187)

0–12 ft	GRAVEL: up to 1 in.; red CLAY matrix.

BMP 953 (Grid Ref. 763187)

0– 9 ft	CLAY: medium to dark brown, plastic.
9–21 ft	CLAY: light grey, plastic.
21–24 ft	GRAVEL.

Remarks: Water (24 ft).

BMP 954 (Grid Ref. 793187)

0– 6 ft	CLAY: medium brown, plastic.
6– 9 ft	CLAY: red to brown, plastic.
9–12 ft	CLAY: medium brown and blue-grey, plastic.
12–15 ft	CLAY: medium brown, plastic.
15–18 ft	CLAY: yellow-brown, plastic; slightly sandy.
18–28 ft	SAND: grey, fine- to medium-grained.
28–30 ft	SHALE: medium to dark grey, hard.

Remarks: Water (18 ft).

BMP 955 (Grid Ref. 793192)

0–12 ft	SHALE: light grey, hard.
12–18 ft	SHALE: medium brown, soft; white CLAY in part.
18–36 ft	SHALE: dark grey to black, soft; small seams dull sooty COAL, 27–36 ft.

BMP 956 (Grid Ref. 756182)

0–12 ft	CLAY: light grey, plastic; reddish in part, 9–12 ft.
12–18 ft	CLAY: medium to dark brown, plastic.
18–18+ ft	CLAY: light brown, plastic passing (18–21 ft) into
18+–24 ft	SHALE: light brown, soft.
24–30 ft	SHALE: medium to dark brown and dark grey.

BMP 957 (Grid Ref. 755174)

0– 9 ft	SANDSTONE: grey and red, fine- to medium-grained, decomposed.
9–18 ft	SHALE: medium to dark brown, soft.
18–24 ft	SHALE: brown to black, coaly in part.
24–30 ft	SHALE: light grey, fairly hard.

13. Deposit Cl 13, Mount Gravatt–Belmont—continued

BMP 959 (Grid Ref. 767167)

0–18 ft	SHALE: light grey, hard.
18–30 ft	CLAY: medium to dark brown, plastic; light-coloured towards bottom.

BMP 960 (Grid Ref. 768174)

0– 6 ft	CLAY: medium brown, plastic.
6–12 ft	SHALE: medium brown, soft; sandy in part, 9–12 ft.
12–18 ft	SHALE: grey to medium brown, hard.
18–30 ft	SHALE: light to medium brown, soft.

BMP 961 (Grid Ref. 762164)

0–18 ft	SHALE: light brown, hard.
18–30 ft	SHALE: medium brown, soft, clayey.

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14. Deposit Cl 14, Gumdale

Logs by: J. W. Laycock

BMP 367 (Grid Ref. 968299)

*	0–12 ft	CLAY: blue-grey and red, plastic.
*	12–15 ft	CLAY: grey-brown, plastic.
*	15–24 ft	CLAY: medium to light grey, plastic.

BMP 368 (Grid Ref. 957300)

*	0–12 ft	CLAY: grey to brown, plastic.
*	12–18 ft	CLAY: light grey, plastic.

Remarks: Water (18 ft).

BMP 369 (Grid Ref. 965290)

0– 9 ft	CLAY: grey to brown, plastic.
9–12 ft	CLAY: grey to red, plastic.
12–15 ft	CLAY: light to medium brown, plastic; few quartz pebbles.
15–18 ft	CLAY: medium brown, plastic.
18–24 ft	CLAY: medium brown, very sandy.
24–27 ft	SANDSTONE: light grey, fine-grained, decomposed.

Remarks: Water (27 ft).

BMP 370 (Grid Ref. 963279)

0– 9 ft	CLAY: grey to brown, plastic.
9–15 ft	CLAY: light grey, very sandy (fine-grained).
15–18 ft	CLAY: red to grey, sandy (fine-grained).

Remarks: Water (18 ft).

BMP 371 (Grid Ref. 953280)

*	0– 6 ft	CLAY: light to medium brown, plastic.
*	6–12 ft	CLAY: grey to brown, plastic.
*	12–18 ft	CLAY: light grey to red, plastic.

BMP 372 (Grid Ref. 962268)

0–27 ft	CLAY: medium grey to red, plastic.
27–30 ft	CLAY: red, plastic, sandy.

BMP 1011 (Grid Ref. 962272)

0– 3 ft	LOAM: grey, sandy.
3– 9 ft	CLAY: grey and red, plastic.
9–21 ft	CLAY: grey to brown, plastic.
21–24 ft	CLAY: light to medium grey, plastic.
24–30 ft	CLAY: red to brown, plastic.
30–51 ft	CLAY: medium brown, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

14. Deposit Cl 14, Gumdale—continued

BMP 1012 (Grid Ref. 963275)

0–15 ft	CLAY: grey to brown, plastic, sandy; few pebbles, 9–12 ft.
15–18 ft	CLAY: grey and brown, very sandy (medium-grained).
18–27 ft	CLAY: light to medium brown, plastic.
27–30 ft	CLAY: light brown, plastic.

BMP 1013 (Grid Ref. 982277)

0–27 ft	CLAY: grey to brown.
27–29 ft	SAND: with angular quartz pebbles up to 1 in.
29–30 ft	CLAY: green to brown, plastic.
30–36 ft	BASALT: decomposed.

Remarks: Water (6 ft).

BMP 1014 (Grid Ref. 973277)

0–12 ft	CLAY: medium brown, plastic.
12–18 ft	CLAY: light grey and red, plastic.
18–24 ft	CLAY: medium brown, plastic.
24–27 ft	CLAY: medium to dark grey, plastic.
27–36 ft	SAND: medium grey, fine-grained, clayey in part.
36–39 ft	SAND and GRAVEL.
39–42 ft	BASALT: fairly hard.

Remarks: Water (24 ft).

BMP 1015 (Grid Ref. 964283)

0–20 ft	CLAY: grey and medium brown, plastic.
20–42 ft	SAND: light grey, fine-grained; numerous angular quartz pebbles up to 1 in., 27–30 ft. and 36–39 ft; clayey, 27–30 ft.
42–48 ft	CLAY: red-brown, plastic = decomposed BASALT.

Remarks: Water (20 ft).

BMP 1016 (Grid Ref. 964286)

0–12 ft	CLAY: medium brown, plastic.
12–15 ft	CLAY: red-brown, plastic.
15–24 ft	SAND: light grey, medium-grained; coarser-grained, 21–24 ft.
24–36 ft	SAND: grey and brown, coarse-grained.
36–42 ft	SAND: brown, very coarse-grained.

BMP 1017 (Grid Ref. 966293)

0– 9 ft	CLAY: medium brown, plastic.
9–15 ft	CLAY: grey to brown, plastic.
15–42 ft	SAND: grey to brown, coarse-grained.
42–51 ft	SAND: grey to brown, very coarse-grained; pebbly.

BMP 1018 (Grid Ref. 963299)

0–27 ft	CLAY: medium brown, plastic.
27–39 ft	SAND: grey and brown, medium-grained.
39–45 ft	SAND: grey, clayey; few pebbles.

Remarks: Water (28 ft).

BMP 1019 (Grid Ref. 971298)

0–12 ft	CLAY: red-brown, plastic.
12–18 ft	CLAY: greenish and yellow; numerous soft, green, clayey fragments of decomposed BASALT.
18–36 ft	BASALT: decomposed.

BMP 1022 (Grid Ref. 980316)

0– 3 ft	LOAM: grey, sandy.
3– 6 ft	CLAY: medium to dark brown, plastic.
6– 9 ft	SHALE: light grey, hard.
9–12 ft	SILTSTONE: light grey, hard.
12–30 ft	CLAY: yellow-brown, plastic; very silty, 12–24 ft.
30–39 ft	CLAY: medium brown, plastic.
39–48 ft	CLAY: dark grey, plastic.
48–51 ft	CLAY: grey to brown, plastic.

Remarks: Water (51 ft).

14. Deposit Cl 14. Gumdale—continued

BMP 1025 (Grid Ref. 979307)

0– 6 ft	SOIL: red, clayey.
6–12 ft	SHALE: light grey, hard.
12–18 ft	CLAY: grey to brown, plastic.
18–30 ft	CLAY: medium brown, plastic.

BMP 1027 (Grid Ref. 970264)

0–18 ft	CLAY: medium brown, plastic.
18–30 ft	CLAY: red, plastic; slightly sandy.
30–36 ft	CLAY: medium brown, plastic.

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15. Deposit Cl 15, Ferny Grove

Logs by: N. A. H. Simmonds

BMP 860 (Grid Ref. 329470)

*0– 6 ft	LOAM: dark brown, sandy with GRAVEL.
6–21 ft	CLAY: light to medium brown, sandy.
*21–24 ft	CLAY: light grey, chloritic; few quartz pebbles.

BMP 861 (Grid Ref. 329465)

0– 3 ft	LOAM: medium brown, clayey.
* 3–15 ft	CLAY: medium brown; sandy, 6–15 ft; pebbly, 9–15 ft.
15–18 ft	CLAY: light brown and blue-grey, sandy; few quartzite pebbles.
18–21 ft	CLAY: light grey, chloritic, gravelly.
21–24 ft	CLAY: sandy, chloritic.

BMP 862 (Grid Ref. 335464)

0– 3 ft	LOAM: black, clayey.
3– 6 ft	CLAY: light to medium brown, chloritic.
6–15 ft	CLAY: light brown, sandy; gravelly, 9–12 ft.

Remarks: Drilling stopped by boulder.

BMP 863 (Grid Ref. 341460)

0– 3 ft	SOIL: light brown.
3– 6 ft	CLAY: light brown, sandy.
6– 9+ ft	CLAY: dark brown, sericitic passing (9–12 ft) into
9+–18 ft	SAND and GRAVEL: light brown, clayey.
18–21 ft	CLAY: medium brown, sandy.
21–24 ft	PHYLLITE: weathered.

Remarks: Water (20 ft).

BMP 864 (Grid Ref. 325466)

0– 3 ft	LOAM: dark brown.
*3– 6 ft	CLAY: medium brown, sericitic.
6–12 ft	CLAY: medium brown, sandy (fine-grained), sericitic; some black clay, 9–12 ft.
*12–15 ft	CLAY: red-brown, sandy.
15–30 ft	CLAY: light brown, sandy.

BMP 866 (Grid Ref. 325460)

0– 3 ft	LOAM.
3– 6 ft	CLAY: dark grey, plastic, sericitic.
6– 9 ft	CLAY: light brown, sandy; few pebbles.
9–12 ft	CLAY: red-brown and medium grey, sandy; some pebbles.
12–15 ft	CLAY: light brown, sandy.
15–18 ft	CLAY: light brown, sandy (fine-grained), sericitic.
18–24 ft	PHYLLITE: weathered.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

15. Deposit Cl 15, Ferny Grove—continued

BMP 867 (Grid Ref. 313467)

0– 3 ft	LOAM: gravelly.
3– 9 ft	CLAY and GRAVEL: medium brown.
9–12+ ft	CLAY: medium brown, sandy (coarse-grained); gravelly passing (12–15 ft) into
12+–18 ft	CLAY: black, plastic, sericitic.
18–21 ft	CLAY: black, non-plastic, sandy.
21–27 ft	CLAY: red-brown, sandy, sericitic.
27–30 ft	PHYLLITE.

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16. Deposit Cl 16, Ferny Grove

Logs by: N. A. H. Simmonds

BMP 841 (Grid Ref. 377459)

0– 3 ft	SOIL: black.
3– 3+ ft	CLAY: dark grey, plastic passing (3–6 ft) into
3+– 6 ft	CLAY: light brown, sandy.
6– 9 ft	SAND: light grey, dry, clayey; nodular.
* 9–12 ft	CLAY: light brown and light grey, sandy.
* 12–18 ft	CLAY: light brown, sandy.
* 18–24 ft	CLAY: medium grey, sandy.
24–30 ft	GRANITE: decomposed.

BMP 870 (Grid Ref. 372458)

0– 3 ft	LOAM: black, sandy.
3– 6 ft	SAND: light brown and grey, clayey.
6–12 ft	CLAY: black and blue, sandy.
12–24 ft	CLAY: dark to light brown, sandy.
24–42 ft	GRANITE: decomposed.

Remarks: Water (about 18 ft).

BMP 871 (Grid Ref. 383455)

0– 3 ft	CLAY: black and grey, plastic.
* 3– 9 ft	CLAY: medium brown, plastic.
* 9–15 ft	CLAY: black; sandy in part, 12–15 ft.
* 15–42 ft	CLAY: medium grey to brown, sandy (fine- to medium-grained).

Remarks: Water (15 ft).

BMP 872 (Grid Ref. 384447)

0– 3 ft	CLAY: black, plastic, slightly sandy.
3– 6+ ft	CLAY: dark grey, sandy passing (6–9 ft) into
6+– 9 ft	SAND: light brown, clayey.
9–15 ft	CLAY: medium brown, very sandy.
15–24 ft	SAND: clayey=decomposed GRANITE.

Remarks: Water (9–12 ft).

BMP 873 (Grid Ref. 383453)

0– 3 ft	LOAM: black, plastic, clayey.
3– 6 ft	CLAY: light brown and dark grey, plastic, slightly sandy.
6– 9 ft	CLAY: medium brown, plastic, sandy (fine-grained)
9–18 ft	SAND: light brown, clayey.

Remarks: Water (about 12 ft).

BMP 874 (Grid Ref. 379455)

0– 3 ft	LOAM: with black, plastic CLAY.
* 3– 6 ft	CLAY: grey and brown mottled, plastic, sandy.
* 6–18 ft	CLAY: light brown, sandy.

Remarks: Water (15 ft).

BMP 877 (Grid Ref. 381456)

0– 3 ft	LOAM: sandy.
* 3–12 ft	CLAY: blue-grey and light brown, plastic.
12–27 ft	CLAY: medium brown, sandy.
27–30 ft	CLAY: red-brown=decomposed GRANITE.

Remarks: Water (12–18 ft).

16. Deposit Cl 16, Ferny Grove—continued

BMP 878 (Grid Ref. 382458)

0– 3 ft	LOAM: sandy.
* 3–12 ft	CLAY: blue-grey and light brown, plastic; slightly sandy, 9–12 ft.
* 12–18 ft	CLAY: medium brown, plastic; very slightly sandy.
18–21 ft	CLAY: sandy.

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17. Deposit Cl 17, Aspley

Logs by: J. W. Laycock

BMP 23 (Grid Ref. 588570)

0– 8 ft	CLAY and SILTSTONE: brown with a few small pebbles; micaceous in part.
8– 9 ft	LIMESTONE.

BMP 24 (Grid Ref. 575566)

0– 3 ft	CLAY: red, plastic.
3– 6 ft	CLAY: red and white; with carbonaceous partings.
* 6– 9+ ft	CLAY: dark brown to red, highly carbonaceous passing (9–12 ft) into
* 9+–12+ ft	CLAY: white passing (12–15 ft) into
12+–15 ft	SHALE: black, carbonaceous.
15–18 ft	CLAY: dark brown to black and white.
18–21 ft	CLAY: white and black, carbonaceous.
21–24 ft	SHALE: black, carbonaceous.
* 24–30 ft	SHALE: light to medium brown; with coaly partings.

BMP 25 (Grid Ref. 587565)

* 0– 3 ft	CLAY: light brown, plastic.
3– 7 ft	CLAY: light brown, sandy.
7–12 ft	LIMESTONE.

BMP 26 (Grid Ref. 584565)

* 0– 3 ft	CLAY: medium to dark brown.
3–16 ft	CLAY: dark brown.
16–21 ft	SANDSTONE: light grey, medium-grained, weathered.

BMP 27 (Grid Ref. 582566)

0– 3 ft	CLAY: red and grey mottled, plastic.
3– 6 ft	CLAY: light brown.
6–12 ft	CLAY: medium to dark brown and grey with carbonaceous partings; minor micaceous SILTSTONE, 9–12 ft.
12–15 ft	LIMESTONE and SHALE: dark brown.

BMP 28 (Grid Ref. 579566)

0– 9 ft	CLAY: yellow-brown with occasional red siltstone pebbles.
* 9–12 ft	CLAY: medium brown to white, carbonaceous in part.
* 12–15 ft	CLAY: brown, very carbonaceous.
*15–18+ ft	CLAY: black passing (18–21 ft) into
18+–21 ft	CLAY: light brown.
21–24 ft	CLAY: black.
24–30 ft	SHALE: medium brown.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

17. Deposit Cl 17, Aspley—continued

BMP 29 (Grid Ref. 577567)

0– 4 ft	CLAY: medium brown, carbonaceous.
4– 6 ft	SHALE: black, carbonaceous.
* 6–15 ft	CLAY: white, plastic.
* 15–18 ft	CLAY: light brown, plastic.
18–24 ft	SHALE: black, carbonaceous with interbedded medium brown CLAY
*24–30 ft	CLAY: yellow-brown.

BMP 30 (Grid Ref. 582564)

0– 4 ft	CLAY: yellow-brown, plastic.
4–12 ft	SANDSTONE: yellow-brown, decomposed.
12–18 ft	SHALE: light brown.

BMP 31 (Grid Ref. 584564)

0– 6 ft	SHALE: medium brown.
6– 9 ft	SANDSTONE: grey, fine- to medium-grained.

BMP 32 (Grid Ref. 587567)

0– 3 ft	CLAY: sandy.
3– 6 ft	CLAY: light brown, plastic.
* 6–12+ ft	CLAY: red-brown passing (12–15 ft) into
12+–15 ft	SANDSTONE: light brown, fine-grained, micaceous; few carbonaceous fragments.

BMP 33 (Grid Ref. 587570)

0– 6+ ft	CLAY: light brown, sandy; with occasional quartz and charcoal fragments passing (6–9 ft) into
* 6+– 9 ft	SANDSTONE: fine-grained.
9–12 ft	CLAY: light brown, grey in part, sandy, carbonaceous.
12–15 ft	CLAY: dark chocolate brown and grey, sandy in part.
*15–21 ft	CLAY: light brown and red, carbonaceous.
21–24 ft	CLAY: dark chocolate brown, carbonaceous.
24–30 ft	SHALE: black, carbonaceous.

BMP 34 (Grid Ref. 584567)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+–3+ ft	CLAY: red passing (3–6 ft) into
3+– 7 ft	SILTSTONE: brown, micaceous; with occasional quartz pebbles.

BMP 35 (Grid Ref. 582567)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 3 ft	CLAY: brown.
* 3–15 ft	CLAY: red and grey mottled; slightly sandy and carbonaceous below 9 ft.
15–18 ft	CLAY: grey to brown, carbonaceous.
18–21 ft	CLAY: dark chocolate brown.
21–27 ft	SHALE: black, carbonaceous.

BMP 36 (Grid Ref. 579564)

0– 3 ft	CLAY: brown and black, sandy.
* 3–15 ft	CLAY: red-brown, plastic; grey in part 9–12 ft.
15–18 ft	CLAY: light brown and white.
18–21 ft	SILTSTONE: yellow-brown.

17. Deposit Cl 17, Aspley—continued

BMP 37 (Grid Ref. 579563)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 3 ft	CLAY: red and grey.
* 3– 6+ ft	CLAY: red and white mottled passing (6–9 ft) into
6+–12+ ft	SANDSTONE: light grey, medium-grained, weathered; with quartz and ferruginous pebbles passing (12–15 ft) into
12+–15 ft	SILTSTONE: medium brown, micaceous.

BMP 38 (Grid Ref. 576564)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 6 ft	CLAY: dark brown and dark blue-black.
* 6–12 ft	CLAY: red and grey mottled.
12–12+ ft	CLAY: red passing (12–15 ft) into
12+–21 ft	SANDSTONE: light grey, decomposed.

BMP 39 (Grid Ref. 576567)

0– 6 ft	SILTSTONE: yellow, weathered.
6–27 ft	SILTSTONE: light brown, micaceous.

18. Deposit Cl 18, Boondall

Logs by: J. W. Laycock

BMP 492 (Grid Ref. 661643)

0– 6 ft	CLAY: dark chocolate brown, plastic.
6–15 ft	CLAY: light grey to light red-brown, plastic.
* 15–18 ft	CLAY: light brown, plastic.
18–24 ft	CLAY: light brown to greenish.

BMP 494 (Grid Ref. 670630)

0– 9 ft	CLAY: medium brown, plastic.
9–18 ft	CLAY: grey-brown, plastic.
18–21 ft	CLAY: greenish, plastic.

BMP 524 (Grid Ref. 675632)

0– 6 ft	SOIL: dark red, clayey.
* 6–21 ft	CLAY: light grey, light brown and red-brown, plastic.

BMP 525 (Grid Ref. 673644)

0– 6 ft	CLAY: dark chocolate brown, plastic; with numerous granules.
6– 9 ft	CLAY: red-brown, plastic; with numerous shale fragments.
9–12 ft	CLAY: light grey to light brown, plastic.
* 12–18 ft	CLAY: light grey, plastic.
18–21 ft	CLAY: light grey to light brown, plastic.
21–30 ft	CLAY: medium brown, plastic.

BMP 535 (Grid Ref. 663652)

0– 3 ft	LOAM: sandy.
3–15 ft	CLAY: light grey-brown, plastic.
15–21 ft	CLAY: red, plastic; numerous ironstone nodules.

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

19. Deposit Cl 19, Sandgate–Brackenridge

Logs by: J. W. Laycock

BMP 465 (Grid Ref. 634684)

0– 6 ft	CLAY: light pinkish, plastic.
6–12 ft	CLAY: light grey to red, plastic.
12–18 ft	CLAY: blue-grey to red, plastic.
18–30 ft	CLAY: red-brown and greenish, with numerous greenish nodules of basalt, vesicular in part.

BMP 479 (Grid Ref. 663715)

0– 3 ft	SOIL: black, numerous ironstone nodules.
3–12 ft	CLAY: blue-grey, plastic.
*12–21 ft	CLAY: light grey and red.
21–27 ft	CLAY: light grey, very plastic (decomposed ?basalt).

Remarks: Water (27 ft).

BMP 480 (Grid Ref. 664697)

0– 9 ft	CLAY: grey to light yellow-brown, plastic.
9–12 ft	CLAY: light grey, plastic.
*12–24 ft	CLAY: blue-grey and red, plastic.
24–30 ft	CLAY: yellow-green, plastic (?=decomposed BASALT)

BMP 481 (Grid Ref. 647698)

0– 3 ft	CLAY: brown, plastic.
3– 6 ft	CLAY: brown, plastic, sandy.
6–24 ft	CLAY: light to medium brown and greenish, plastic; numerous waxy fragments (?= decomposed BASALT).

Remarks: Water (24 ft).

BMP 482 (Grid Ref. 653713)

* 0–18 ft	CLAY: blue-grey and red, plastic.
* 18–24 ft	CLAY: grey to light brown, plastic.

BMP 483 (Grid Ref. 648688)

0– 3 ft	SOIL: black.
* 3–12 ft	CLAY: greenish-brown, plastic; numerous green waxy fragments.
* 12–24 ft	CLAY: red-brown, plastic, sandy; numerous waxy fragments.

BMP 484 (Grid Ref. 643673)

0–12 ft	CLAY: blue-grey to brown, plastic.
12–18 ft	CLAY: blue-grey, plastic.
18–21+ ft	CLAY: reddish, plastic; few granules passing (21–24 ft) into
21+–24 ft	SANDSTONE: light grey, coarse-grained.

Remarks: Water (24 ft).

BMP 532 (Grid Ref. 664707)

0– 3 ft	CLAY: chocolate brown, plastic, sandy; numerous small ironstone nodules.
3– 6 ft	CLAY: red, sandy; few nodules.
6– 9 ft	CLAY: light grey to red, sandy in part; few nodules.
9–12 ft	CLAY: light grey to light brown, plastic.
12–21 ft	CLAY: light green to light brown, plastic.
21–27 ft	CLAY: medium brown, plastic.
27–30 ft	CLAY: greenish-red, whitish in part.

(12–21 ft, 21–27 ft, 27–30 ft: ?=decomposed BASALT)

BMP 534 (Grid Ref. 657684)

0– 3 ft	LOAM: grey, sandy.
3– 6 ft	CLAY: yellow-brown, plastic.
6– 9 ft	CLAY: blue-grey to brown, plastic.
9–12 ft	CLAY: blue-grey to red, plastic.
12–24 ft	CLAY: red-brown, plastic.

19. Deposit Cl 19, Sandgate–Brackenridge—continued

BMP 1095 (Grid Ref. 638672)

0– 3 ft	CLAY: brown, plastic; very sandy.
3–12 ft	CLAY: grey and brown, very sandy.
12–18 ft	CLAY: medium grey, plastic.
18–27 ft	CLAY: medium brown, plastic.
27–30 ft	SAND: medium-grained, gravelly in part.

Remarks: Water (30 ft).

BMP 1096 (Grid Ref. 643677)

0–12 ft	CLAY: light to medium brown, plastic.
12–24 ft	CLAY: medium brown, plastic.
24–30 ft	SAND: grey, coarse-grained, angular; gravelly in part.

Remarks: Water (30 ft).

BMP 1097 (Grid Ref. 644683)

0–18 ft	CLAY: medium brown, plastic.
18–24 ft	SAND: yellow-brown, medium-grained.

Remarks: Water (21 ft).

BMP 1098 (Grid Ref. 646693)

0– 9 ft	CLAY: dark red, hard.
9–24 ft	CLAY: red, plastic.

BMP 1099 (Grid Ref. 647702)

0– 6 ft	CLAY: light brown, plastic.
6–12 ft	CLAY: light grey to red-brown, plastic.
12–18 ft	CLAY: red-brown to medium brown, plastic.
18–21 ft	CLAY: medium brown, plastic.
21–30 ft	CLAY: medium grey to brown; numerous soft yellow shaly fragments.

BMP 1100 (Grid Ref. 650705)

0–30 ft	CLAY: red-brown, plastic.

BMP 1101 (Grid Ref. 641709)

0–18 ft	CLAY: light grey to light brown, plastic.
18–30 ft	CLAY: light brown, plastic.

BMP 1102 (Grid Ref. 633708)

0–30 ft	CLAY: light grey, plastic.

BMP 1104 (Grid Ref. 658704)

0–18 ft	CLAY: red-brown, plastic.
18–30 ft	BASALT: decomposed.

Remarks: Water (24 ft).

BMP 1105 (Grid Ref. 658696)

0– 6 ft	CLAY: grey-brown, plastic.
6–21 ft	CLAY: medium brown to red-brown, plastic.
21–36 ft	CLAY: brown, plastic, silty.

Remarks: Water (36 ft).

BMP 1106 (Grid Ref. 652689)

0–18 ft	CLAY: medium brown, plastic.

Remarks: Water (18 ft).

BMP 1107 (Grid Ref. 662678)

0–15 ft	CLAY: medium brown, plastic.
15–30 ft	CLAY: red-brown, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

20. Deposit Cl 20, Brighton

Logs by: J. W. Laycock

BMP 476 (Grid Ref. 634725)

	0– 6 ft	CLAY: red and brown, plastic.
*	6–12 ft	SILTSTONE: light grey, micaceous.
*	12–18 ft	SILTSTONE: light grey to light brown.
*	18–24 ft	SHALE: light brown, very micaceous in part.

BMP 526 (Grid Ref. 647726)

0–21 ft	SILTSTONE: light grey, micaceous, decomposed.

BMP 527 (Grid Ref. 660724)

* 0–18 ft	SILTSTONE: light grey, micaceous, decomposed.

BMP 528 (Grid Ref. 656735)

0– 6 ft	SILTSTONE: red, decomposed.
6– 9 ft	CLAY: red-brown, plastic; numerous yellow shale fragments.
9–12 ft	CLAY: medium brown, micaceous, silty.
12–21 ft	CLAY: light grey and red, plastic; numerous shale fragments.
21–27+ ft	CLAY: medium to dark brown, plastic passing (27–30 ft) into
27+–30 ft	SILTSTONE: light grey, micaceous.

BMP 529 (Grid Ref. 662741)

0– 3 ft	LOAM: silty.
3–12 ft	CLAY: red and grey, plastic, silty.
12–18 ft	SILTSTONE: light grey, micaceous, decomposed.
18–24 ft	SILTSTONE: red-brown, decomposed.

BMP 530 (Grid Ref. 663749)

0– 6 ft	CLAY: black, plastic.
6–12 ft	CLAY: light grey, plastic, sandy in part.

BMP 1109 (Grid Ref. 636723)

0– 3 ft	LOAM: grey, sandy.
3– 9 ft	CLAY: red and grey, silty.
9–15 ft	SILTSTONE: light grey, decomposed.
15–21 ft	SILTSTONE: light grey and light brown.
21–24 ft	SILTSTONE: brown, decomposed.
24–30 ft	CLAY: brown, silty.

BMP 1110 (Grid Ref. 637728)

0– 3 ft	LOAM.
3– 6 ft	CLAY: red, plastic.
6–12 ft	SILTSTONE: light grey, decomposed.
12–24 ft	SILTSTONE: yellow-brown, decomposed.
24–30 ft	CLAY: yellow-brown, plastic.

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21. Deposit Cl 21, Bald Hills

Logs by: J. W. Laycock

BMP 445 (Grid Ref. 569740)

0–18 ft	CLAY: grey to brown, plastic.
18–30 ft	CLAY: light brown, plastic, very sandy.

BMP 448 (Grid Ref. 578735)

0– 6 ft	CLAY: light grey to brown, plastic.
6–18 ft	CLAY: light brown, plastic.
18–24 ft	SAND: coarse-grained, few pebbles.

Remarks: Water (24 ft).

21. Deposit Cl 21, Bald Hills—continued

BMP 450 (Grid Ref. 570724)

	0– 9 ft	CLAY: medium brown, plastic, slightly sandy.
	9–15 ft	CLAY: blue-grey to brown, plastic.
*	15–18 ft	CLAY: light grey, plastic.
	18–27 ft	CLAY: grey to brown, plastic.
	27–30 ft	CLAY: light to medium brown, plastic.

BMP 451 (Grid Ref. 580723)

0– 9 ft	CLAY: medium brown, plastic. sandy.
9–12 ft	CLAY: red and blue-grey, plastic.
12–15 ft	CLAY: red, plastic, sandy.
15–18 ft	CLAY: red-brown, plastic, very sandy.
18–21 ft	SANDSTONE: grey to yellow, decomposed; numerous pebbles.

Remarks: Water (21 ft).

BMP 1111 (Grid Ref. 583722)

0– 9 ft	CLAY: red-brown, plastic.
9–15 ft	CLAY: blue-grey, plastic.
15–18 ft	GRAVEL: pebbles up to ¾ in.

Remarks: Water (18 ft).

BMP 1112 (Grid Ref. 575723)

0–30 ft	CLAY: light brown, plastic.

BMP 1113 (Grid Ref. 565725)

0–12 ft	CLAY: medium brown, plastic.
12–18 ft	CLAY: medium to dark brown, plastic, sandy.
18–24 ft	CLAY: yellow-brown, plastic, sandy.
24–30 ft	SANDSTONE: grey to brown, fine-grained, decomposed.

BMP 1114 (Grid Ref. 562729)

0–24 ft	CLAY: medium brown, plastic.
24–30 ft	SAND: grey to brown, fine-grained, clayey.

Remarks: Water (30 ft).

BMP 1115 (Grid Ref. 570733)

0–18 ft	CLAY: light to medium brown, plastic.
18–24 ft	CLAY: blue-grey, plastic.

BMP 1116 (Grid Ref. 574734)

0– 9 ft	CLAY: brown, very sandy.
9–24 ft	CLAY: light brown, plastic.
24–30 ft	GRAVEL: grey clayey matrix.

Remarks: Water (30 ft).

BMP 1117 (Grid Ref. 582736)

0–15 ft	CLAY: light to medium brown, plastic.
15–18 ft	CLAY: dark brown, plastic.
18–24 ft	SAND: grey, coarse-grained, gravelly.

BMP 1118 (Grid Ref. 560722)

0– 9 ft	SAND: coarse-grained, pebbly; brown clayey matrix.
9–12 ft	CLAY: medium brown, plastic.
12–18 ft	CLAY: medium brown and slightly greenish, plastic.
18–27 ft	CLAY: medium green, plastic.
27–30 ft	SHALE: medium green, soft.

BMP 1120 (Grid Ref. 556718)

0–15 ft	CLAY: medium to dark brown, plastic.
15–30 ft	CLAY: black, plastic; numerous soft black shale fragments.

Remarks: Water (30 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

22. Deposit Cl 22, Bald Hills

Logs by: J. W. Laycock

BMP 421 (Grid Ref. 589655)

	0– 9 ft	CLAY: red-brown, plastic; numerous hard red ironstone nodules.
*	9–15 ft	CLAY: light grey and red, plastic; few ironstone pebbles.
*	15–21 ft	CLAY: red-brown and grey; few ironstone nodules.
	21–27 ft	CLAY: red-brown, plastic.
	27–30 ft	CLAY: yellow-brown, plastic.

BMP 422 (Grid Ref. 592673)

*	0–12 ft	CLAY: dark chocolate brown, plastic.
*	12–18 ft	CLAY: light grey, plastic.
	18–21 ft	CLAY: light brown, plastic.
	21–24 ft	CLAY: brown to dark green, plastic.
	24–27 ft	CLAY: medium to dark brown, plastic.
	27–30 ft	SHALE: medium to dark green, calcareous.

BMP 423 (Grid Ref. 581673)

	0– 6 ft	CLAY: medium to dark brown, plastic.
	6– 9 ft	CLAY: red-brown, plastic.
	9–12 ft	CLAY: light brown to greenish, plastic.
*	12–30 ft	CLAY: medium green, plastic, calcareous.

BMP 424 (Grid Ref. 580665)

*	0– 9 ft	CLAY: dark chocolate brown, plastic.
	9–18 ft	CLAY: light brown, plastic.
	18–24 ft	CLAY: light yellow-brown, plastic.
	24–30 ft	CLAY: dark green, plastic, calcareous.

BMP 457 (Grid Ref. 604688)

	0–12 ft	SANDSTONE: red and grey, medium-grained, decomposed.
*	12–21 ft	CLAY: light grey, plastic.
*	21–24 ft	CLAY: light to medium grey, plastic.
	24–27 ft	CLAY: red and grey, plastic.
	27–30 ft	CLAY: dark grey, plastic.

BMP 458 (Grid Ref. 593681)

*	0–12 ft	CLAY: medium brown, plastic.
*	12–27 ft	CLAY: light yellow-brown.
	27–30 ft	CLAY: dark green, plastic.

BMP 459 (Grid Ref. 602670)

*	0–15 ft	CLAY: dark brown, plastic.
*	15–21 ft	CLAY: red-brown, plastic.
	21–24 ft	CLAY: light grey to red, plastic.
	24–27 ft	CLAY: light grey.

BMP 460 (Grid Ref. 611669)

0–18 ft	CLAY: dark chocolate brown, plastic.
18–27+ ft	CLAY: red-brown, plastic passing (27–30 ft) into
27+–30 ft	SANDSTONE: decomposed.

Remarks: Water (29 ft).

BMP 464 (Grid Ref. 610681)

	0– 3 ft	LOAM: grey to black, sandy.
	3– 9 ft	CLAY: light grey to brown, plastic, sandy.
*	9–21 ft	CLAY: medium brown, plastic.

BMP 489 (Grid Ref. 602653)

*	0–12 ft	CLAY: dark chocolate brown, plastic.
*	12–15 ft	CLAY: grey to brown, plastic.
	15–18 ft	CLAY: greenish, plastic.

Remarks: Water (18 ft).

22. Deposit Cl 22, Bald Hills—continued

BMP 1064 (Grid Ref. 572670)

0–18 ft	CLAY: light brown, plastic.
18–27 ft	CLAY: medium brown, plastic; dark green at bottom.

BMP 1065 (Grid Ref. 577673)

0–30 ft	CLAY: dark brown, plastic.

BMP 1066 (Grid Ref. 587673)

0–12 ft	CLAY: medium to dark brown, plastic.
12–24 ft	CLAY: light to medium brown, plastic.
24–30 ft	CLAY: dark green-blue, plastic, calcareous

BMP 1067 (Grid Ref. 592676)

0– 6 ft	CLAY: dark brown, plastic.
6–24 ft	CLAY: light to medium brown, plastic.
24–30 ft	CLAY: dark green and blue, plastic, calcareous.

BMP 1068 (Grid Ref. 594685)

0– 3 ft	LOAM: brown.
3–18 ft	CLAY: red-brown, plastic.

Remarks: Water (18 ft).

BMP 1069 (Grid Ref. 590690)

0– 6 ft	CLAY: dark brown, plastic.
6–12 ft	CLAY: light grey, plastic.
12–30 ft	CLAY: light brown, plastic.

BMP 1071 (Grid Ref. 597671)

0–18 ft	CLAY: dark brown, plastic.
18–27 ft	CLAY: medium brown, plastic.
27–30 ft	CLAY: dark green, plastic.

BMP 1072 (Grid Ref. 606670)

0– 6 ft	CLAY: dark brown, plastic.
6–24 ft	CLAY: medium brown, plastic.
24–30 ft	SHALE: dark green.

Remarks: Water (24 ft).

BMP 1073 (Grid Ref. 592667)

0–12 ft	CLAY: brown, plastic.

Remarks: Water (12 ft).

BMP 1074 (Grid Ref. 590663)

0–18 ft	CLAY: light grey, plastic.
18–27 ft	CLAY: light to medium brown.
27–30 ft	CLAY: dark green, plastic.

BMP 1075 (Grid Ref. 590658)

0– 6 ft	CLAY: dark brown, plastic.
6–30 ft	CLAY: medium brown, plastic.

BMP 1076 (Grid Ref. 593653)

0–27 ft	CLAY: medium brown, plastic.
27–30 ft	CLAY: brown to greenish, plastic.

Remarks: Water (24 ft).

BMP 1077 (Grid Ref. 598652)

0– 6 ft	CLAY: dark brown, plastic.
6– 9 ft	CLAY: light grey to brown, plastic.
9–12 ft	CLAY: red-brown, plastic.
12–18 ft	CLAY: medium brown, plastic.
18–30 ft	CLAY: yellow-brown, plastic; dark green in part.

Remarks: Water (24 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

22. Deposit Cl 22, Bald Hills—continued

BMP 1078 (Grid Ref. 606651)

0–12 ft	CLAY: red-brown, plastic.
12–21 ft	CLAY: brown to purplish, plastic.
21–30 ft	CLAY: light brown, plastic.

BMP 1081 (Grid Ref. 593645)

0– 9 ft	CLAY: dark brown, plastic.
9–24 ft	CLAY: light to medium brown, plastic.
24–27 ft	CLAY: dark green, calcareous.
27–30 ft	SHALE: dark green, calcareous.

BMP 1082 (Grid Ref. 587650)

0–15 ft	CLAY: medium brown, plastic.
15–24 ft	CLAY: yellow-brown, plastic.
24–27 ft	CLAY: dark green, calcareous.
27–30 ft	SHALE: dark green.

BMP 1084 (Grid Ref. 587645)

0–24 ft	CLAY: light to medium brown, plastic.
24–30 ft	CLAY: dark green, plastic, calcareous.

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23. Deposit Cl 23, Bald Hills

Logs by: J. W. Laycock

BMP 385 (Grid Ref. 499623)

0– 3 ft	LOAM: dark brown.
3– 6 ft	LOAM: medium brown, clayey.
6–12 ft	CLAY: light grey, plastic.
12–30 ft	CLAY: red and grey, plastic, sandy in part; numerous granules and small pebbles below 21 ft.

Remarks: Water (12–30 ft).

BMP 386 (Grid Ref. 508621)

0– 0+ ft	LOAM: clayey passing (0–3 ft) into
0+–12 ft	CLAY: light grey and red, plastic.
12–15 ft	CLAY: red-brown, plastic; few ironstone granules.
15–18 ft	CLAY: brown, plastic; few granules.
18–21 ft	CLAY: brown, very sandy.

BMP 387 (Grid Ref. 512629)

0– 3 ft	LOAM: brown.
3– 6 ft	CLAY: medium brown, plastic; few granules and small nodules.
6– 9 ft	CLAY: brown.
9–15 ft	CLAY: red-brown, plastic, sandy in part.
15–21 ft	CLAY: yellow-brown, plastic; few ferruginous nodules.
* 21–24 ft	CLAY: grey and brown, plastic.
24–30 ft	CLAY: red-brown, plastic, carbonaceous in part.

Remarks: Water (30 ft).

BMP 388 (Grid Ref. 513642)

0– 3 ft	LOAM: red-brown.
3– 6 ft	CLAY: red; numerous granules and few small pebbles.
* 6–18 ft	CLAY: blue-grey, plastic.
18–30 ft	CLAY: light grey and red, plastic.

23. Deposit Cl 23, Bald Hills—continued

BMP 391 (Grid Ref. 514652)

0– 3 ft	LOAM: brown.
3– 6 ft	CLAY: brown, plastic.
6– 9 ft	CLAY: red, sandy.
9–12 ft	CLAY: light grey and brown, very sandy.
12–15+ ft	CLAY: red, sandy; numerous small pebbles passing (15–18 ft) into
15+–21 ft	CLAY: blue-grey, plastic.
21–24 ft	CLAY: light grey to purplish.
24–27 ft	CLAY: light grey, sandy.

BMP 392 (Grid Ref. 517662)

* 0– 9 ft	CLAY: light grey, plastic.
9–12 ft	CLAY: light grey and purplish, plastic.
12–18 ft	CLAY: light grey to purplish, plastic.
*18–30 ft	CLAY: medium brown to light grey, plastic.

BMP 393 (Grid Ref. 528661)

0– 3 ft	SOIL: red-brown, clayey.
3–12 ft	CLAY: red; numerous small pebbles.
12–18+ ft	CLAY: light grey to red, plastic passing (18–21 ft) into
18+–21 ft	SANDSTONE: red, fine-grained.

BMP 394 (Grid Ref. 527653)

* 0– 9 ft	CLAY: light grey.
9–12 ft	CLAY: light grey to reddish, plastic.
12–15 ft	SHALE: medium brown.
15–18 ft	CLAY: grey to brown, plastic.
18–24 ft	CLAY: red-brown, plastic.

BMP 395 (Grid Ref. 539662)

* 0–18 ft	CLAY: red, plastic; few granules and small pebbles.

BMP 396 (Grid Ref. 549660)

* 0– 9 ft	CLAY: light grey to brown, plastic.
9–15 ft	CLAY: blue-grey to red, plastic.
15–24 ft	CLAY: medium grey, plastic.
24–30 ft	CLAY: light to medium brown, plastic.

BMP 397 (Grid Ref. 547652)

0–15 ft	CLAY: medium brown to greenish, plastic.
15–24 ft	CLAY: light brown to greenish, plastic.

BMP 398 (Grid Ref. 545644)

0– 9 ft	CLAY: red, very hard; few granules.
* 9–24 ft	CLAY: light grey and red, plastic.

BMP 399 (Grid Ref. 537651)

0– 6 ft	CLAY: red, very hard; few granules.
6–12 ft	CLAY: red, very hard; numerous quartz and basalt pebbles.
12–15 ft	CLAY: light grey, plastic.
15–24 ft	CLAY: grey and red, numerous small waxy granules.
24–30 ft	CLAY: medium grey to brown, plastic.

BMP 400 (Grid Ref. 544630)

0– 3 ft	SOIL: red-brown, clayey.
3– 6 ft	CLAY: red-brown, plastic.
6–18 ft	CLAY: light grey to brown, plastic.
18–24 ft	CLAY: light brown, plastic; numerous small chips of soft shale.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

23. Deposit Cl 23, Bald Hills—continued

BMP 401 (Grid Ref. 542619)

0– 3 ft	SOIL: red, clayey.
3– 6 ft	CLAY: red, sandy.
6–15 ft	SANDSTONE: red, fine- to medium-grained, decomposed.
15–24 ft	CLAY: light grey to brownish, plastic.

BMP 402 (Grid Ref. 531618)

0– 3 ft	CLAY: red-brown.
3– 6 ft	CLAY: light grey and red, plastic.
6– 9 ft	CLAY: light grey.
9–12 ft	CLAY: light grey and light brown.
12–15 ft	CLAY: medium brown.
15–18 ft	CLAY: light brown.
18–24 ft	CLAY: grey to brown, shaly in part.

BMP 404 (Grid Ref. 523631)

0– 9 ft	CLAY: light grey to brown, plastic.
9–24 ft	CLAY: light grey, plastic.

Remarks: Water (24 ft).

BMP 405 (Grid Ref. 525641)

0– 3 ft	SOIL: red, clayey.
* 3–24 ft	CLAY: light grey to brown, plastic.

BMP 406 (Grid Ref. 540639)

0–30 ft	CLAY: light grey to red-brown, plastic.

BMP 407 (Grid Ref. 555637)

* 0– 3 ft	CLAY: brown, plastic.
3–12 ft	CLAY: light grey, plastic.
* 12–18 ft	CLAY: light brown, plastic.
18–27 ft	CLAY: light to medium brown, plastic.

BMP 408 (Grid Ref. 565635)

* 0–15 ft	CLAY: light brown, plastic.
15–18 ft	CLAY: medium grey to brown, plastic.
18–21 ft	CLAY: light brown, plastic.
21–30 ft	CLAY: light to medium brown, plastic; numerous light grey shale chips at base.

BMP 412 (Grid Ref. 564628)

* 0– 3 ft	CLAY: red-brown.
3– 6 ft	CLAY: red, sandy.
6–30 ft	CLAY: light grey to reddish, plastic; few ironstone nodules.

BMP 413 (Grid Ref. 551615)

* 0– 6 ft	SILTSTONE: light grey to white.
6–12 ft	SILTSTONE: red.
* 12–21+ ft	SILTSTONE: light grey to brown passing (21–24 ft) into
21+–24 ft	SILTSTONE: red.

BMP 431 (Grid Ref. 543671)

0– 9 ft	CLAY: medium to dark brown, plastic.
9–21 ft	CLAY: yellow-brown, plastic.
21–24 ft	CLAY: brown to purplish, plastic.
* 24–27 ft	CLAY: light brown to greenish; numerous nodules of light yellow calcareous shale.
27–33 ft	CLAY: medium brown, plastic.
33–36 ft	CLAY: yellow-brown, plastic; numerous nodules of yellow calcareous shale and few nodules of decomposed basalt.

Remarks: Water (36 ft).

BMP 1042 (Grid Ref. 548616)

0– 9 ft	CLAY: light brown, plastic.
9–15 ft	SHALE: light brown, fairly hard.
15–30 ft	CLAY: light to medium brown, plastic.

23. Deposit Cl 23, Bald Hills—continued

BMP 1043 (Grid Ref. 541616)

0– 9 ft	CLAY: light brown, plastic.
9–15 ft	SHALE: light brown, fairly hard.
15–30 ft	CLAY: light to medium brown, plastic.

BMP 1044 (Grid Ref. 536617)

0–12 ft	CLAY: deep red, plastic.
12–18 ft	CLAY: light grey, plastic.
18–24 ft	CLAY: light grey and light brown plastic.
24–30 ft	CLAY: medium brown, plastic.

BMP 1045 (Grid Ref. 542624)

0– 6 ft	SOIL: red, clayey.
6–15 ft	CLAY: light grey and red, plastic.
15–21 ft	CLAY: light grey to brown, plastic.
21–24 ft	CLAY: medium to dark brown, plastic.
24–30 ft	CLAY: light to medium brown, plastic.

BMP 1046 (Grid Ref. 545638)

0– 9 ft	SOIL: red, clayey.
9–18 ft	CLAY: light grey and red, plastic.
18–21 ft	CLAY: red, plastic.
21–24 ft	CLAY: light grey, plastic.

Remarks: Water (24 ft).

BMP 1047 (Grid Ref. 549638)

0– 6 ft	SOIL: brown, clayey.
6–30 ft	CLAY: medium to dark brown, plastic.

BMP 1048 (Grid Ref. 535639)

0– 3 ft	LOAM: dark red.
3– 9 ft	CLAY: dark red, sandy.
9–24 ft	CLAY: light grey, plastic.
24–30 ft	CLAY: light grey to light brown, plastic.

BMP 1049 (Grid Ref. 518642)

0– 9 ft	CLAY: dark brown, plastic, sandy.
9–12 ft	CLAY: red to brown, plastic.
12–18 ft	CLAY: light grey to light brown, plastic.
18–24 ft	CLAY: light grey, plastic.
24–30 ft	CLAY: dark brown to black, plastic.

BMP 1050 (Grid Ref. 511637)

0– 6 ft	CLAY: red to brown, plastic.
6–18 ft	CLAY: light grey, plastic.
18–21 ft	CLAY: light brown, plastic.
21–24 ft	CLAY: red to brown and grey, plastic.
24–27 ft	CLAY: light brown, plastic.
27–30 ft	CLAY: light grey, plastic.

BMP 1051 (Grid Ref. 514647)

0–18 ft	CLAY: red, sandy; with angular quartz pebbles up to ½ in. at bottom.

BMP 1052 (Grid Ref. 523662)

0– 9 ft	SOIL: red, clayey; few pebbles.
9–30 ft	CLAY: light grey and light brown, plastic.

BMP 1053 (Grid Ref. 534663)

0– 9 ft	CLAY: red to brown, sandy.
9–15 ft	CLAY: light to medium brown, plastic.
15–18 ft	SHALE: light grey, hard.

BMP 1054 (Grid Ref. 538667)

0– 3 ft	CLAY: green to brown, plastic.
3–30 ft	CLAY: light green, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

23. Deposit Cl 23, Bald Hills—continued

BMP 1055 (Grid Ref. 544662)

0–21 ft	CLAY: light to medium brown, plastic.
21–30 ft	CLAY: dark green, plastic; numerous white calcareous fragments.

BMP 1058 (Grid Ref. 561640)

0–18 ft	CLAY: medium brown, plastic.
18–24 ft	CLAY: light to medium brown, plastic.
24–30 ft	CLAY: dark green, plastic.

BMP 1059 (Grid Ref. 570634)

0–12 ft	CLAY: medium brown.
12–30 ft	CLAY: red and brown; numerous light brown shale chips.

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24. Deposit Cy 1, Lytton

Logs by: J. W. Laycock

BMP 575 (Grid Ref. 853422)

* 0–15 ft	MUD: black.
Remarks:	Water (9 ft).

BMP 576 (Grid Ref. 866427)

0– 9 ft	MUD: medium brown.
9–15 ft	SILT: medium grey to black; few small shells, 12–15 ft.

BMP 577 (Grid Ref. 881447)

0– 9 ft	SILT: medium brown, micaceous in part.
9–12 ft	MUD: medium grey to black.

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25. Deposit Cy 2, Bulwer Island

Logs by: J. W. Laycock

BMP 548 (Grid Ref. 846461)

* 0–12 ft	MUD: dark brown to black; few shells.
12–18 ft	SAND: medium-grained.
Remarks:	Water (12 ft).

BMP 549 (Grid Ref. 860463)

0– 3 ft	MUDSTONE: black to dark brown.
3– 9 ft	SAND: brown, medium-grained, fairly clean.
9–24 ft	SAND: black, fine-grained, muddy.

BMP 550 (Grid Ref. 867467)

0–15 ft	SAND: brown, medium-grained, few small shells.
15–18 ft	MUD: black, hard.
18–24 ft	SAND: medium- to coarse-grained, muddy; numerous small shells.

BMP 551 (Grid Ref. 865470)

0– 9 ft	SAND: brown, medium-grained; few shells.
9–18 ft	MUD: black; numerous shells.
18–33 ft	SAND: fine-grained, muddy; numerous shells.

BMP 565 (Grid Ref. 842466)

* 0– 9 ft	MUD: black.
9–30 ft	SAND: brown, fine-grained.
Remarks:	Water (3–6 ft).

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26. Deposit Cy 3, Bald Hills

Logs by: J. W. Laycock

BMP 446 (Grid Ref. 569749)

* 0–24 ft	MUD: black.
Remarks:	Water (about 6 ft).

BMP 447 (Grid Ref. 568762)

0– 3 ft	SAND: medium-grained.
3– 6 ft	SAND and GRAVEL.
6–21 ft	MUD: black, sandy.
Remarks:	Water (3–6 ft).

BMP 449 (Grid Ref. 592740)

0– 9 ft	MUD: black.
9–12 ft	CLAY: green; few recent shells.

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27. Minor Clay Occurrences

Logs by: J. W. Laycock

BMP 4 (Grid Ref. 938200; Map Sheet 1)

0– 3 ft	LOAM: sandy.
3– 5 ft	SAND: light grey; numerous small quartz pebbles.
5– 9 ft	CLAY: red.
9–12 ft	CLAY: blue and red mottled.
12–15 ft	CLAY: red.
15–18 ft	CLAY: light red, sandy; numerous small quartz pebbles at top.
18–24 ft	CLAY: red and grey, very sandy; numerous quartz pebbles.
Remarks:	Water (21 ft).

BMP 5 (Grid Ref. 929190; Map Sheet 1)

0– 3 ft	SHALE: brown.
3–12 ft	SHALE: light brown to grey, sandy; few small ferruginous pebbles, 6–12 ft.
12–15 ft	SHALE: medium grey.

BMP 11 (Grid Ref. 905210; Map Sheet 3)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+–12 ft	CLAY: white, plastic; sandy near base.
12–24 ft	SANDSTONE: light grey, medium-grained, decomposed.

BMP 15 (Grid Ref. 914220; Map Sheet 3)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+–12 ft	SANDSTONE: grey, medium-grained; decomposed.
12–15 ft	SHALE: black to dark brown, carbonaceous.

BMP 17 (Grid Ref. 917232; Map Sheet 3)

0– 3 ft	SHALE: grey, fossiliferous.
3– 3+ ft	SHALE: grey, fossiliferous, hard passing (3–6 ft) into
3+– 6 ft	SHALE: dark grey, softer.
6–12 ft	CLAY: light to dark grey.
12–24 ft	SHALE: dark grey, carbonaceous.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 19 (Grid Ref. 938226; Map Sheet 3)

0– 3 ft	SANDSTONE: green to brown, very weathered.
3– 6 ft	CLAY: red and grey mottled, sandy.
6– 9 ft	CLAY: white to cream, plastic.
9– 9+ ft	CLAY: red and grey, sandy passing (9–12 ft) into
9+–12 ft	CLAY: green to light brown.
12–15 ft	CLAY: light brown; numerous small quartz pebbles.
15–18 ft	CLAY: red.
18–21 ft	CLAY: cream, plastic.
21–27 ft	CLAY: cream to mushroom-coloured.
27–30 ft	CLAY: light brown, plastic.

BMP 22 (Grid Ref. 917218; Map Sheet 3)

0– 3 ft	SHALE: light brown.
3– 6 ft	CLAY: light grey, very sandy.
6–12 ft	CLAY: red and grey mottled, sandy.
12–15+ ft	CLAY: blue-grey, plastic passing (15–18 ft) into
15+–18 ft	SHALE: carbonaceous.
18–24 ft	SHALE: dark brown.
24–30 ft	CLAY: red and grey.

BMP 41 (Grid Ref. 941208; Map Sheet 3)

0– 6 ft	SANDSTONE: medium-grained, decomposed, ironstained.
6– 6+ ft	CLAY: white plastic passing (6–9 ft) into
6+–12 ft	SANDSTONE: red, medium-grained.
12–30 ft	CLAY: grey to white.

Log by: I. G. Sanker

BMP 43 (Grid Ref. 919220; Map Sheet 3)

0– 6 ft	SANDSTONE: red, decomposed, clayey.
6– 9 ft	SANDSTONE: white, decomposed, very clayey.
9–15 ft	CLAY: light grey to white, sandy.
15–15+ ft	SILTSTONE: clayey passing (15–18 ft) into
15+–21 ft	SHALE and SILTSTONE: black.

Logs by: J. W. Laycock

BMP 45 (Grid Ref. 939208; Map Sheet 3)

0– 3 ft	SILTSTONE: white, ironstained in part, clayey.
3–15+ ft	SILTSTONE: medium grey passing (15–18 ft) into
15+–21 ft	SHALE: light to dark grey.
21–21+ ft	SILTSTONE: red passing (21–24 ft) into
21+–24 ft	SANDSTONE: very fine-grained, ferruginous.
24–30 ft	SILTSTONE: medium grey; shaly in part, 27–30 ft.

BMP 56 (Grid Ref. 888178; Map Sheet 1)

0– 3 ft	CLAY: red, few small pebbles.
3– 6 ft	CLAY: white plastic.
6– 9+ ft	CLAY: grey, plastic passing (9–12 ft) into
9+–15 ft	SHALE: black, hard at base.

BMP 65 (Grid Ref. 960150; Map Sheet 1)

0– 3 ft	CLAY: grey to brown, plastic.
3– 9 ft	CLAY: light grey, plastic.
9–15 ft	SHALE: grey to brown, clayey in part.
15–21 ft	SHALE: grey, soft 18–21 ft.

27. Minor Clay Occurrences—continued

BMP 76 (Grid Ref. 940150; Map Sheet 1)

0– 3 ft	CLAY: grey.
3–12 ft	SHALE: medium brown, carbonaceous.
12–15 ft	SHALE: grey to brown.
15–18 ft	SILTSTONE: grey to light brown, micaceous.

BMP 94 (Grid Ref. 912162; Map Sheet 1)

0– 3 ft	CLAY: brown.
3– 9 ft	SHALE: brown to greenish.
9–15 ft	SHALE: light to medium brown.

BMP 101 (Grid Ref. 860092; Map Sheet 1)

0– 3 ft	CLAY: medium brown, plastic.
3– 6 ft	CLAY: medium grey to brown, plastic.
6–18 ft	CLAY: light to medium grey, plastic.
18–24 ft	CLAY: blue-grey to chocolate, plastic; becoming sandy then shaly towards base.
24–30 ft	SHALE: brown to black; silty in part at base.

BMP 104 (Grid Ref. 899058; Map Sheet 1)

0– 9 ft	SANDSTONE: light grey, medium-grained; weathered and ironstained.
9–15 ft	SHALE: grey to medium brown; silty in part; dark grey in part, 12–15 ft.

BMP 105 (Grid Ref. 908045; Map Sheet 1)

0– 3 ft	CLAY: brown, very sandy.
3– 9 ft	SHALE: light to medium brown, clayey in part.
9–15 ft	SHALE: medium brown.

BMP 120 (Grid Ref. 806078; Map Sheet 1)

0– 3 ft	LOAM and SOIL: sandy and clayey.
3–15 ft	CLAY: white, plastic.
15–21 ft	CLAY: light yellow, plastic, sandy.
21–39 ft	CLAY: light grey, plastic, sandy (very fine-grained).

BMP 129 (Grid Ref. 908057; Map Sheet 1)

0– 9 ft	SHALE: white, hard.
9–15 ft	SHALE: light brown, hard.
15–21 ft	SHALE: white, hard.

BMP 133 (Grid Ref. 902093; Map Sheet 1)

0– 3 ft	LOAM: yellow-brown, sandy.
3– 6 ft	SHALE: white to yellow.
6–12+ ft	CLAY: light grey, plastic passing (12–15 ft) into
12+–18 ft	SHALE: medium brown to black.
18–18+ ft	SHALE: black, carbonaceous, hard; few ironstained pebbles passing (18–21 ft) into
18+–21 ft	CLAY and SANDSTONE: white; medium-grained.
21–24+ ft	CLAY: cream, plastic passing (24–27 ft) into
24+–27 ft	SHALE: black, hard.

BMP 134 (Grid Ref. 903100; Map Sheet 1)

0– 3 ft	CLAY: brown, sandy.
3– 9 ft	SANDSTONE: medium brown, medium-grained, decomposed.
9–21 ft	SHALE: black, highly carbonaceous; brown to black, 18–21 ft.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 143 (Grid Ref. 863088; Map Sheet 1)
- 0– 3 ft LOAM: sandy.
- 3–12+ ft SANDSTONE: yellow to brown, fine- to medium-grained
  passing (12–15 ft) into
- 12+–15 ft CLAY: white.
- 15–21 ft SHALE: medium brown.
- 21–27 ft CLAY: dark brown, plastic.
- 27–30 ft SHALE: medium to dark grey.

BMP 144 (Grid Ref. 862082; Map Sheet 1)
- 0– 9 ft CLAY: chocolate, plastic.
- 9–21 ft SANDSTONE: light grey to greenish; iron-stained, decomposed.
- 21–24 ft SHALE: medium to dark grey.

BMP 148 (Grid Ref. 904045; Map Sheet 1)
- 0–12+ ft SHALE: light grey to light brown, soft
  passing (12–15 ft) into
- 12+–18 ft SHALE: black, carbonaceous.
- 18–24 ft SHALE: medium brown to light brown.
- 24–24+ ft SHALE: light grey, soft
  passing (24–27 ft) into
- 24+–27 ft SANDSTONE: fine-grained.

BMP 149 (Grid Ref. 905058; Map Sheet 1)
- 0– 6 ft CLAY: red; occasional small ironstone pebbles.
- 6– 9 ft CLAY: white.
- 9–21 ft SHALE: hard.

BMP 151 (Grid Ref. 885050; Map Sheet 1)
- 0– 3 ft CLAY: brown.
- 3– 9 ft CLAY: light grey.
- 9–15 ft SANDSTONE: red, medium-grained, hard; numerous small black " spots ".

BMP 161 (Grid Ref. 830063; Map Sheet 1)
- 0– 6 ft SANDSTONE: yellow-brown, medium-grained, decomposed; few ferruginous sandstone nodules.
- 6–12 ft SANDSTONE: light grey, medium-grained, decomposed, ironstained.
- 12–27 ft CLAY: light grey, plastic.
- 27–33 ft SANDSTONE: red to brown, very fine-grained, decomposed.

BMP 163 (Grid Ref. 831067; Map Sheet 1)
- 0– 6 ft SOIL: red, clayey.
- 6–12+ ft SANDSTONE: yellow-brown, medium-grained, decomposed
  passing (12–15 ft) into
- 12+–27 ft CLAY: light grey to white, plastic.
- 27–30 ft CLAY: red and grey, plastic.

BMP 189 (Grid Ref. 936227; Map Sheet 3)
- * 0– 3 ft CLAY: medium brown; numerous small sandstone pebbles.
- * 3–15 ft CLAY: light grey, plastic, ironstained in part.
- * 15–18 ft CLAY: red, very sandy.
- * 18–24 ft SHALE: black.

BMP 190 (Grid Ref. 918228; Map Sheet 3)
- * 0– 3 ft CLAY: medium brown, plastic.
- * 3– 6 ft SHALE: grey-brown, fairly hard.
- * 6–12 ft SHALE: black, carbonaceous.
- * 12–15+ ft SHALE: light grey
  passing (15–18 ft) into
- 15+–21+ ft SANDSTONE: red-brown, fine- to medium-grained, decomposed
  passing (21–24 ft) into
- 21+–24 ft CLAY: light grey, plastic.
- 24–30 ft SHALE: light to medium grey, soft.

27. Minor Clay Occurrences—continued

BMP 193 (Grid Ref. 950207; Map Sheet 3)
- 0– 3 ft LOAM: sandy.
- 3– 6 ft SANDSTONE: red, medium-grained, ferruginous.
- * 6–18 ft CLAY: light grey, plastic.

BMP 194 (Grid Ref. 930189; Map Sheet 1)
- * 0–12 ft SHALE: medium brown, fairly hard.
- *12–24 ft SILTSTONE: light to medium grey.

BMP 195 (Grid Ref. 927182; Map Sheet 1)
- * 0– 6 ft CLAY: dark grey to black, soft.
- * 6– 9 ft CLAY: brown to black, sandy.
- 9–12 ft SANDSTONE: grey, fine- to medium-grained, decomposed.

Remarks: Water (9 ft).

BMP 198 (Grid Ref. 890130; Map Sheet 1)
- * 0– 3 ft SHALE: dark grey, hard; numerous plant fossils.
- * 3– 9 ft SHALE: light to dark grey.
- 9–12 ft SHALE: light to dark grey, carbonaceous in part.
- 12–18 ft SANDSTONE: grey, fine-grained, decomposed, ironstained; some black shaly bands.
- 18–24 ft SANDSTONE: grey to greenish, fine- to medium-grained, decomposed.

BMP 202 (Grid Ref. 961150; Map Sheet 1)
- 0– 3 ft CLAY: brown, plastic.
- 3– 6 ft CLAY: light grey to brown, plastic.
- * 6– 9 ft SHALE: medium brown, fairly hard, fossiliferous.
- 9–12 ft CLAY: light grey.
- 12–15 ft CLAY: light grey to brown, plastic; carbonaceous in part.
- * 15–18 ft SHALE: light brown, fairly soft; carbonaceous, fossiliferous.
- 18–24 ft SHALE: light brown, soft.
- 24–30 ft SHALE: medium grey to brown, soft.

BMP 203 (Grid Ref. 936153; Map Sheet 1)
- * 0– 6 ft CLAY: light grey.
- * 6–12 ft SHALE: grey to brown, very hard.

BMP 210 (Grid Ref. 861091; Map Sheet 1)
- * 0– 6 ft CLAY: grey to brown, plastic.
- * 6–12 ft CLAY: light grey, plastic.
- *12–18 ft CLAY: blue-grey, plastic.
- * 18–21 ft CLAY: grey to brown, soft, shaly.
- * 21–24 ft CLAY: brown, plastic, shaly in part.
- * 24–30 ft SHALE: medium grey, soft.

BMP 216 (Grid Ref. 893095; Map Sheet 1)
- * 0–24 ft CLAY: light grey, plastic; few ironstone nodules, 15–24 ft; brown, shaly in part, 15–24 ft.

BMP 217 (Grid Ref. 897104; Map Sheet 1)
- * 0– 3 ft CLAY: brown, plastic.
- * 3– 6 ft CLAY: grey.
- 6– 9 ft SHALE: grey to brown and black, fairly soft; clayey in part.
- * 9–12 ft SHALE: black to brown, carbonaceous.
- * 12–15 ft SHALE: black, carbonaceous; coaly in part.
- 15–18 ft SHALE and SILTSTONE: grey and brown.
- 18–30 ft SHALE: black, coaly; silty in part; clayey, 27–30 ft.

Remarks: Water (27 ft).

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 218 (Grid Ref. 886050; Map Sheet 1)

*	0– 9 ft	CLAY: light grey, plastic; numerous hard ferruginous shale nodules.
*	9–15 ft	SHALE: brown, fairly hard; sandy in part, 12–15 ft.
*	15–18 ft	SHALE: brown, fairly hard; silty in part; few nodules.
	18–24 ft	SHALE: dark grey, soft.

BMP 228 (Grid Ref. 804077; Map Sheet 1)

*	0–24 ft	CLAY: light grey, plastic; very fine sand grains towards base.

Remarks: Water (21 ft).

BMP 254 (Grid Ref. 735049 Map Sheet 1)

*	0–12 ft	CLAY: light brown, plastic.
	12–18 ft	SANDSTONE: red, medium-grained, decomposed; few hard black pebbles; light grey plastic CLAY in part, 15–18 ft.
	18–24 ft	SANDSTONE: medium brown, medium-grained, decomposed.

BMP 259 (Grid Ref. 739020; Map Sheet 1)

*	0– 6 ft	CLAY: dark brown, plastic.
*	6–15+ ft	CLAY: medium to dark chocolate, plastic; gritty, 9–12 ft
		passing (15–18 ft) into
	15+–18 ft	BASALT: decomposed.
*	18–24 ft	CLAY: light to medium brown, plastic.
*	24–30 ft	CLAY: greenish-brown, plastic; few basalt pebbles.

BMP 262 (Grid Ref. 751024; Map Sheet 1)

	0– 0+ ft	LOAM: sandy
		passing (0–3 ft) into
*	0+– 9 ft	CLAY: red-brown, plastic.
	9–18 ft	CLAY: light to medium brown, plastic; greenish in part; very gritty, 12–15 ft.

Remarks: Water (12 ft).

BMP 275 (Grid Ref. 738067; Map Sheet 1)

	0– 0+ ft	LOAM: sandy
		passing (0–3 ft) into
	0+– 6 ft	CLAY: brown, plastic.
	6– 9 ft	CLAY: medium brown, plastic.
	9–15 ft	BASALT: decomposed.

BMP 283 (Grid Ref. 761096; Map Sheet 1)

	0– 9 ft	SANDSTONE: light grey, medium-grained, decomposed; few quartz pebbles, 6–9 ft.
*	9–21 ft	CLAY: light grey, plastic; silty in part, 18–21 ft.
*	21–24 ft	CLAY: medium grey to brown, plastic; silty in part.
	24–30 ft	CLAY: medium brown, plastic.

BMP 286 (Grid Ref. 772081; Map Sheet 1)

	0– 6 ft	SANDSTONE: red-brown, medium-grained, decomposed.
	6–10 ft	CLAY: light grey to red, plastic; numerous hard red ironstained nodules, 12–15 ft.

BMP 292 (Grid Ref. 716057; Map Sheet 1)

*	0– 3 ft	CLAY: black, plastic.
*	3– 6 ft	CLAY: brown to greenish; few waxy fragments.
	6–12 ft	CLAY: medium brown, sandy; numerous waxy fragments.

Remarks: Water (12 ft).

27. Minor Clay Occurrences—continued

BMP 294 (Grid Ref. 704054; Map Sheet 1)

*	0– 9 ft	CLAY: light brown; numerous small waxy chips.
*	9–15 ft	CLAY: medium to dark brown, plastic; numerous waxy chips.
	15–18 ft	CLAY: medium to dark brown to greenish, plastic; numerous waxy chips.
	18–24 ft	CLAY: medium to dark brown; numerous waxy chips.
*	24–27 ft	CLAY: red-brown, plastic.
	27–30 ft	CLAY: light brown, plastic; numerous waxy chips.
	30–33 ft	CLAY: brownish; waxy fragments.

BMP 296 (Grid Ref. 697060; Map Sheet 1)

	0– 6 ft	CLAY: grey to dark brown, plastic.
	6– 9 ft	CLAY: light brown, plastic.
	9–24 ft	CLAY: greenish-brown; sandy, 9–21 ft; plastic with few fragments waxy material, 21–24 ft.

BMP 298 (Grid Ref. 710049; Map Sheet 1)

*	0– 3 ft	CLAY: brown, plastic.
*	3– 6 ft	CLAY: light brown, plastic.
	6–12 ft	CLAY: brown to greenish, plastic; numerous waxy fragments.

Remarks: Water (12 ft).

BMP 309 (Grid Ref. 723019; Map Sheet 1)

	0– 3 ft	BASALT: greenish, altered, vesicular.
	3– 6 ft	CLAY: green to brown, plastic.
*	6–18+ ft	CLAY: light grey, plastic
		passing (18–21 ft) into
	18+–21 ft	CLAY: reddish.
	21–24 ft	SANDSTONE: yellow-brown, very fine-grained.
	24–27 ft	CLAY: light brown, plastic.
	27–30 ft	CLAY: medium brown, plastic.

BMP 310 (Grid Ref. 721011; Map Sheet 1)

	0– 3 ft	LOAM: grey, sandy.
*	3– 6 ft	CLAY: yellow-brown, plastic.
	6–12 ft	CLAY: grey to brown, plastic.
*	12–21 ft	CLAY: reddish, plastic.
	21–24 ft	CLAY: medium brown to dark grey, plastic.

Remarks: Water (24 ft).

BMP 311 (Grid Ref. 720002; Map Sheet 1)

	0–15 ft	CLAY: brown to green, plastic; sandy, 3–6 ft.
	15–30 ft	CLAY: yellow-brown to red-brown, plastic; sandy, 18–30 ft.

BMP 312 (Grid Ref. 713022; Map Sheet 1)

	0– 9 ft	SANDSTONE: light grey to red, fine- to medium-grained, decomposed.
*	9–15 ft	CLAY: green to yellow, plastic.
*	15–21 ft	CLAY: blue-grey, plastic; greenish with decomposed BASALT in part, 21–24 ft.
	21–24 ft	CLAY: red-brown to pinkish, plastic.
	24–27 ft	CLAY: medium brown, plastic.
	27–30 ft	CLAY: medium brown to green, plastic.

BMP 313 (Grid Ref. 692017; Map Sheet 1)

	0– 6 ft	BASALT: green, sandy, decomposed.
*	6–18 ft	CLAY: green, plastic; numerous less decomposed basalt chips, 15–18 ft.

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 321 (Grid Ref. 684031; Map Sheet 1)

0– 3 ft	SOIL: red-brown.
3– 6 ft	SANDSTONE: red, medium-grained, decomposed; very clayey.
6– 9 ft	CLAY: light grey, plastic.
* 9–15 ft	SHALE: light grey, very hard.
* 15–18 ft	SHALE: medium grey, hard.
* 18–21 ft	CLAY: medium grey, soft.
* 21–24 ft	CLAY: grey to brown, soft.
* 24–27 ft	CLAY: medium grey, plastic.

BMP 325 (Grid Ref. 668063; Map Sheet 1)

0–15 ft	CLAY: medium brown to grey-brown, very gritty.
15–27 ft	CLAY: yellow-brown to medium brown, plastic.
27–33 ft	CLAY: dark brown to dark green, plastic.

BMP 326 (Grid Ref. 669092; Map Sheet 1)

0– 6 ft	SANDSTONE: yellow-brown, medium-grained, decomposed.
6–18 ft	CLAY: grey-brown, plastic.
18–30 ft	CLAY: light yellow-brown, plastic.

BMP 328 (Grid Ref. 747132; Map Sheet 1)

* 0– 6 ft	CLAY: dark brown, soft.
* 6–21+ ft	CLAY: grey to brown, soft; sandy in part at base
	passing (21–24 ft) into
21+–24 ft	SANDSTONE: light grey, fine- to medium-grained, decomposed; few small hard red ironstone nodules.
24–30 ft	CLAY: medium to dark brown; few hard red ironstone nodules.

BMP 343 (Grid Ref. 794206; Map Sheet 3)

0– 6 ft	CLAY: medium brown; sandy (coarse-grained); few quartzite pebbles, 3–6 ft.
6– 9 ft	CLAY: red-brown, sandy; few quartzite pebbles.
* 9–21 ft	CLAY: light grey, plastic.
* 21–24 ft	SHALE: medium grey, soft.
24–30 ft	SHALE: brown to black, carbonaceous in part.

BMP 345 (Grid Ref. 809207; Map Sheet 3)

* 0–24 ft	SHALE: light grey, soft; greenish, 18–21 ft.
24–30 ft	SHALE: greenish, sandy.

BMP 348 (Grid Ref. 812233; Map Sheet 3)

* 0–15 ft	CLAY: red, very hard; few small quartzite fragments.

BMP 352 (Grid Ref. 838305; Map Sheet 3)

* 0–15 ft	SHALE: light grey to white; black, carbonaceous in part.
* 15–30 ft	SHALE: medium to dark grey.

BMP 353 (Grid Ref. 867346; Map Sheet 3)

* 0–18 ft	TUFF: feldspathic.

BMP 354 (Grid Ref. 878348; Map Sheet 3)

* 0– 6 ft	CLAY: brown to green with green specks.

BMP 356 (Grid Ref. 876317; Map Sheet 3)

0– 0+ ft	LOAM: sandy
	passing (0–3 ft) into
0+– 6 ft	CLAY: grey to red, plastic.
6– 9 ft	SHALE: grey.
9–15 ft	SANDSTONE: light grey, fine-grained, decomposed.
15–18 ft	SANDSTONE: red-brown, fine-grained, decomposed.

27. Minor Clay Occurrences—continued

BMP 358 (Grid Ref. 872301; Map Sheet 3)

0– 3 ft	LOAM: grey, sandy.
3– 6 ft	SANDSTONE: red, fine-grained, decomposed.
6–12 ft	CLAY: red and grey, very sandy.
12–18 ft	CLAY: light grey, plastic, very sandy.
18–21 ft	CLAY: light grey, plastic.
* 21–24 ft	CLAY: light grey and brown to black in part, plastic.
24–27 ft	CLAY: brown to black, carbonaceous.
27–30 ft	CLAY: light grey to brown.

BMP 360 (Grid Ref. 870292; Map Sheet 3)

0– 6 ft	CLAY: red, hard.
6– 9 ft	CLAY: grey and red.
9–12 ft	CLAY: light grey and red, fairly soft; few hard red shale nodules.
12–15 ft	CLAY: light grey, plastic.
15–18 ft	CLAY: light grey to brown, plastic.
18–24 ft	CLAY: grey to brown, dry; few hard brown shale nodules.

BMP 366 (Grid Ref. 900264; Map Sheet 3)

0– 9 ft	CONGLOMERATE.
9–10 ft	SANDSTONE: medium-grained.
10–12 ft	CLAY: light grey.
12–15 ft	SHALE: light grey, soft.
15–24 ft	SHALE: light to medium grey, soft.
24–27 ft	SANDSTONE: light grey, fine-grained, decomposed.

BMP 377 (Grid Ref. 954238; Map Sheet 3)

0– 6 ft	CLAY: brown to greenish, plastic.
* 6– 9 ft	CLAY: brown to red and greenish; numerous soft waxy fragments.
9–12 ft	CLAY: grey to red-brown; waxy fragments.
12–24 ft	CLAY: grey to pinkish, plastic; numerous waxy fragments.

BMP 410 (Grid Ref. 585632; Map Sheet 5)

0–15 ft	CLAY: light grey, plastic.
15–24 ft	CLAY: light grey to light brown, plastic.

BMP 416 (Grid Ref. 568657; Map Sheet 5)

* 0– 0+ ft	CLAY: brown, plastic
	passing (0–3 ft) into
0+–12 ft	CLAY: white, plastic, calcareous.
12–21+ ft	CLAY: greenish, plastic
	passing (21–24 ft) into
21+–24 ft	CLAY: white, plastic.

Remarks: Water (18 ft).

BMP 425 (Grid Ref. 571674; Map Sheet 5)

* 0–21 ft	CLAY: light brown, plastic.
* 21–33 ft	CLAY: light yellow-brown, plastic.
33–39 ft	CLAY: dark green, plastic, calcareous.

BMP 453 (Grid Ref. 600719; Map Sheet 5)

* 0–15+ ft	GREENSTONE: decomposed; highly micaceous and schistose pebbles and quartz pebbles
	passing (15–18 ft) into
15+–18 ft	CLAY: green and yellow.

BMP 454 (Grid Ref. 598707; Map Sheet 5)

0–21 ft	GREENSTONE: decomposed; with quartz pebbles.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 473 (Grid Ref. 597702; Map Sheet 5)

0– 6 ft+	CLAY: light brown, plastic passing (6–9 ft) into
6+–21 ft	SHALE: light to medium brown, few pebbles; carbonaceous streaks, 15–18 ft.
21–27 ft	GREENSTONE: decomposed.

BMP 511 (Grid Ref. 698607; Map Sheet 5)

0–12 ft	CLAY: medium brown, plastic, sandy.
*12–18 ft	CLAY: blue-grey, plastic.
18–30 ft	CLAY: red and blue-grey, plastic.

Remarks: Water (30 ft).

BMP 514 (Grid Ref. 575582; Map Sheet 5)

0– 9 ft	CLAY: blue-grey and red, plastic.
9–21 ft	CLAY: light grey to light brown, plastic.
21–24 ft	CLAY: light brown, plastic.
24–27 ft	CLAY: dark brown, plastic, micaceous.
27–30 ft	CLAY: grey and brown, carbonaceous in part.

Remarks: Water filled hole and overflowed.

BMP 517 (Grid Ref. 667581; Map Sheet 5)

* 0–21 ft	CLAY: light to medium brown, plastic.	
* 21–24 ft	CLAY: light yellow-brown and white, plastic, calcareous	?=decomposed BASALT
* 24–27 ft	CLAY: yellow, white and greenish; numerous small waxy fragments.	?=decomposed BASALT

BMP 518 (Grid Ref. 665571; Map Sheet 5)

0– 3 ft	SILTSTONE: grey, decomposed.
3– 6 ft	CLAY: red-brown, plastic.
6–12 ft	CLAY: blue-grey to red-brown, plastic.
12–15 ft	CLAY: light green.
15–18 ft	CLAY: light yellow-brown, plastic.
18–24 ft	CLAY: light green, plastic; numerous green shale chips.
24–27 ft	CLAY: light brown, plastic.
27–30 ft	CLAY: medium green; numerous green shale fragments.

BMP 522 (Grid Ref. 654608; Map Sheet 5)

* 0– 6 ft	CLAY: dark chocolate, plastic.
* 6–18 ft	CLAY: light to medium brown to greenish, plastic; green shale fragments.
*18–27 ft	CLAY: light green, semi-plastic.

Remarks: Water (27 ft).

BMP 523 (Grid Ref. 678613; Map Sheet 5)

0– 3 ft	SOIL: dark red, clayey.
3– 9 ft	CLAY: red, grey in part; few granules.
9–12 ft	SHALE: medium brown.
12–24 ft	CLAY: medium brown, semi-plastic.

BMP 533 (Grid Ref. 681694; Map Sheet 5)

0– 6 ft	CLAY: medium brown, plastic.
6–12 ft	CLAY: yellow-brown, plastic.
12–21 ft	CLAY: dark grey, plastic.
21–24 ft	CLAY: red; few nodules.

Remarks: Water (24 ft).

BMP 555 (Grid Ref. 834503; Map Sheet 3)

* 0–15 ft	SILT: micaceous.

Remarks: Water (6 ft).

27. Minor Clay Occurrences—continued

BMP 556 (Grid Ref. 840527; Map Sheet 3)

0–24 ft	SILT: light to dark grey.
24–30 ft	MUD: black; numerous large shells.
30–36 ft	SAND: brown, medium-grained; numerous small shells.

Remarks: Water (6 ft).

BMP 558 (Grid Ref. 860535; Map Sheet 3)

0– 9 ft	SILT: dark grey.
9–15 ft	SAND: very fine-grained.

Remarks: Water (6 ft).

BMP 566 (Grid Ref. 818535; Map Sheet 5)

0– 6 ft	SILT: brown.
6–12 ft	SILT: brown to black.
12–15 ft	MUD: black.

Remarks: Water (6 ft).

BMP 567 (Grid Ref. 812523; Map Sheet 3)

* 0– 9 ft	SILT: medium grey to brown.
9–15 ft	SAND: brown, very fine-grained.

Remarks: Water (3–6 ft).

BMP 574 (Grid Ref. 849411; Map Sheet 3)

0– 6 ft	CLAY: blue-grey, plastic.
6–12 ft	SILT: medium brown, minor mica.
12–15 ft	SILT: brown to black; few shells.

Remarks: Water (9 ft).

BMP 579 (Grid Ref. 770306; Map Sheet 3)

0–10 ft	CLAY: medium brown, plastic.
10–12+ ft	SANDSTONE: yellow-brown passing (12–15 ft) into
12+–15 ft	CLAY: sandy.

BMP 580 (Grid Ref. 775300; Map Sheet 3)

0– 6 ft	CLAY: dark brown, plastic.
6– 9 ft	CLAY: medium grey and red, plastic.
9–12 ft	CLAY: red, plastic.
12–15 ft	CLAY: yellow-brown, plastic.
15–18 ft	PHYLLITE: chlorite.

Remarks: Water (18 ft).

BMP 581 (Grid Ref. 778321; Map Sheet 3)

0– 3 ft	Talus.
3– 6 ft	CLAY: dark brown, sandy.
6– 9 ft	CLAY: light grey, plastic.
9–12 ft	CLAY: grey-green, plastic.
12–15 ft	PHYLLITE: chlorite.

BMP 584 (Grid Ref. 794298; Map Sheet 3)

0– 9 ft	CLAY: grey to medium brown, plastic; numerous red shaly nodules.
9–15 ft	CLAY: light grey and red, plastic; numerous red shaly nodules.
* 15–18 ft	CLAY: blue-grey and brown, plastic.
18–24 ft	CLAY: red-brown, plastic.
24–30 ft	CLAY: red, plastic; numerous small nodules.

BMP 586 (Grid Ref. 808283; Map Sheet 3)

0– 6 ft	CLAY: blue-grey, plastic.
6–10 ft	CLAY: yellow-brown, plastic.
10–18 ft	SAND: light grey, fine- to medium-grained, clayey; numerous small pebbles, 15–18 ft.

Remarks: Water (12–15 ft).

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 587 (Grid Ref. 788285; Map Sheet 3)

*	0– 9 ft	CLAY: grey to brown, plastic; few sand grains.
*	9–15 ft	CLAY: light grey, plastic; few red shaly nodules.
*	15–18 ft	CLAY: medium brown, plastic.
*	18–24 ft	CLAY: red-brown, plastic.
*	24–30 ft	SHALE: medium brown; carbonaceous in part; sandy in part.

BMP 588 (Grid Ref. 774276; Map Sheet 3)

0– 9 ft	TUFF: white.

BMP 590 (Grid Ref. 781275; Map Sheet 3)

0– 6 ft	TUFF: white.

BMP 591 (Grid Ref. 785275; Map Sheet 3)

0– 6 ft	TUFF: white, hard.

BMP 592 (Grid Ref. 791280; Map Sheet 3)

	0– 6 ft	CLAY: red and brown, plastic, sandy.
*	6–15 ft	SHALE: light grey to light brown; fairly hard.
*	15–18 ft	CLAY: light grey to light yellow, plastic.
	18–21 ft	GRAVEL: numerous small quartzite pebbles up to 1 in.
	21–24 ft	CLAY: red, plastic (decomposed TUFF).
	*24–30 ft	SHALE: medium to dark brown, highly carbonaceous.

BMP 597 (Grid Ref. 794256; Map Sheet 3)

	0– 3 ft	CLAY: red and brown, plastic, sandy.
	3– 6 ft	CLAY: light grey and red, plastic, sandy.
*	6–15 ft	CLAY: light grey to light green, plastic in part; dry with few quartz grains in part.
	15–18 ft	CLAY: red and purplish, dry, fairly hard.
	18–18+ ft	CLAY: light green, plastic in part passing (18–21 ft) into
	18+–21 ft	GRAVEL: quartzitic.

BMP 598 (Grid Ref. 793248; Map Sheet 3)

0– 6 ft	CLAY: greenish. and TUFF: decomposed.

BMP 606 (Grid Ref. 698117; Map Sheet 1)

	0–12 ft	BASALT: decomposed.
*	12–18 ft	CLAY: red, plastic, slightly sandy.
*	18–27 ft	CLAY: red-brown, plastic.

BMP 607 (Grid Ref. 697118; Map Sheet 1)

0–12 ft	SHALE: light grey.
12–18 ft	CLAY: light grey and red, plastic; few ironstone nodules.

BMP 612 (Grid Ref. 698997; Map Sheet 1)

	0–15 ft	CONGLOMERATE: rounded pebbles to 1 in.
	15–18+ ft	SANDSTONE: light grey, fine- to medium-grained, decomposed passing (18–21 ft) into
	18+–21+ ft	SHALE: grey-brown and purple; carbonaceous in part passing (21–24 ft) into
*	21+–27 ft	SHALE: black, highly carbonaceous; coaly in part.
*	27–30 ft	SHALE: medium grey.

27. Minor Clay Occurrences—continued

BMP 613 (Grid Ref. 690013; Map Sheet 1)

0–15 ft	CONGLOMERATE: numerous rounded to subangular pebbles of black quartz.
15–21+ ft	CLAY: light grey, plastic passing (21–24 ft) into
21+–24 ft	CLAY: red, plastic.

BMP 625 (Grid Ref. 567005; Map Sheet 1)

0– 9+ ft	CLAY: medium grey to medium brown, plastic passing (9–12 ft) into
9+–18 ft	SAND: light grey, fine- to medium-grained.
Remarks:	Water (18 ft).

BMP 628 (Grid Ref. 568021; Map Sheet 1)

0–12 ft	SILTSTONE: grey to brown, decomposed.
12–24 ft	SAND: light grey to brown, fine-grained.

BMP 633 (Grid Ref. 544049; Map Sheet 1)

0– 6 ft	CLAY: brown, sandy.
6–12 ft	SAND: medium brown, fine-grained.
12–21 ft	CLAY: medium grey, plastic.

BMP 642 (Grid Ref. 525111; Map Sheet 2)

0– 9 ft	CLAY: medium to dark brown, plastic.
9–18 ft	CLAY: green to brown, plastic; numerous basalt fragments and hard yellow cherty nodules.

BMP 645 (Grid Ref. 493097; Map Sheet 2)

0– 6 ft	CLAY: light to medium brown, plastic.
6– 9 ft	SILTSTONE: light brown, decomposed.
9–12 ft	CLAY: medium brown, plastic.
12–15 ft	SILTSTONE: light to medium brown, decomposed.

BMP 652 (Grid Ref. 502030; Map Sheet 2)

0– 6 ft	CLAY: red, sandy.
6–12 ft	SILTSTONE: light grey and red.
12–18 ft	CLAY: grey and red, plastic.

BMP 665 (Grid Ref. 551907; Map Sheet 1)

0–15 ft	CLAY: medium grey, plastic, silty.
15–30 ft	SANDSTONE: medium grey, fine-grained, decomposed.

BMP 667 (Grid Ref. 569937; Map Sheet 1)

0–15 ft	CLAY: light to medium grey, plastic, sandy in part.
15–24 ft	CLAY: red-brown and grey, plastic.

BMP 668 (Grid Ref. 579952; Map Sheet 1)

0–18 ft	CLAY: light grey, plastic, sandy in part; few ironstone nodules at base.

BMP 669 (Grid Ref. 581968; Map Sheet 1)

0–15 ft	CLAY: medium brown, plastic; carbonaceous in part.
15–18 ft	SAND: coarse-grained, gravelly in part.
Remarks:	Water (12 ft).

BMP 678 (Grid Ref. 536963; Map Sheet 1)

0– 6 ft	SHALE: light grey.
6– 9 ft	SILTSTONE: light grey.
9–15 ft	SANDSTONE: grey and red, fine-grained.
15–18 ft	SHALE: red-brown.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 680 (Grid Ref. 528950; Map Sheet 2)

0– 9 ft	CLAY: light grey, plastic.
9–12 ft	CLAY: blue-grey, plastic.
12–18 ft	CLAY: red and grey, plastic.
18–21 ft	CLAY: light grey and brown, plastic; silty.
21–24 ft	SILTSTONE: yellow-brown.

BMP 681 (Grid Ref. 522965; Map Sheet 2)

0– 3 ft	LOAM: grey.
3– 9 ft	CLAY: red, plastic, sandy; few quartzite pebbles.
9–12 ft	CLAY: red and grey, plastic, sandy.
12–24 ft	CLAY: light grey to brown, silty.

BMP 682 (Grid Ref. 516962; Map Sheet 2)

* 0– 9 ft	SHALE: grey to brown, oolitic.
9–18 ft	CLAY: medium to dark green, plastic.
18–24 ft	CLAY: green, very silty.
24–30 ft	SANDSTONE: medium brown, very fine-grained, decomposed.

BMP 683 (Grid Ref. 479983; Map Sheet 2)

0–18 ft	SILTSTONE: light grey.
18–21 ft	SANDSTONE: light grey, very fine-grained, very hard.

BMP 684 (Grid Ref. 482992; Map Sheet 2)

0– 9 ft	SANDSTONE: yellow-brown, fine-grained; numerous hard red sandstone nodules at base.
9–18 ft	CLAY: red and grey to brown, plastic; light grey, very hard SILTSTONE at base.

BMP 685 (Grid Ref. 472993; Map Sheet 2)

0–12 ft	SANDSTONE: grey and brown, fine- to medium-grained.
*12–27 ft	CLAY: light grey, plastic.
27–30 ft	SANDSTONE: light grey, fine-grained.

BMP 695 (Grid Ref. 413996; Map Sheet 2)

0– 6 ft	CLAY: light grey, plastic.
6–12 ft	SILTSTONE: light grey.
12–18 ft	SANDSTONE: grey to brown, fine-grained, decomposed.

BMP 705 (Grid Ref. 481142; Map Sheet 2)

0– 6 ft	CLAY: dark brown, plastic, sandy.
6– 9 ft	SAND: medium brown, fine-grained.
9–18 ft	SILTSTONE: light grey, decomposed.
18–24 ft	SILTSTONE: light grey to greenish-brown.
24–30 ft	SHALE: medium grey to brown.

BMP 709 (Grid Ref. 493161; Map Sheet 2)

0–21 ft	CLAY: medium brown to red-brown, plastic.
21–27 ft	CLAY: dark green, plastic with dark green SHALE.

Remarks: Water (27 ft).

BMP 715 (Grid Ref. 545198; Map Sheet 1)

0– 9 ft	CLAY: blue-grey and red, plastic, sandy.
9–12 ft	CLAY: medium brown to grey, plastic, sandy.
12–21 ft	CLAY: light grey to light brown, plastic; sandy.
21–24 ft	CLAY: light brown, plastic.
24–30 ft	CLAY: red, plastic, sandy; numerous granules up to $\frac{1}{8}$ in.
30–39 ft	CLAY: red and medium brown, plastic, very sandy; with granules and rounded pebbles ($\frac{1}{8}$–$\frac{3}{4}$ in.).

27. Minor Clay Occurrences—continued

BMP 716 (Grid Ref. 525182; Map Sheet 2)

0–12 ft	CLAY: dark brown, plastic.
12–18 ft	CLAY: dark brown, plastic; gypsum crystals to $\frac{1}{4}$ in.

BMP 721 (Grid Ref. 195045; Map Sheet 2)

* 0–24 ft	CLAY: medium brown, plastic, sandy; few calcareous nodules near bottom.

BMP 722 (Grid Ref. 197054; Map Sheet 2)

0– 9 ft	CLAY: dark brown, plastic, sandy.
9–18 ft	CLAY: medium brown, plastic, sandy.
18–24 ft	CLAY: brown to green, plastic.
24–30 ft	CLAY: medium brown, plastic; numerous calcareous nodules.

BMP 723 (Grid Ref. 198063; Map Sheet 2)

0–21 ft	CLAY: medium brown, plastic, sandy; few calcareous nodules.
21–30 ft	SAND: brown, fine-grained.

BMP 731 (Grid Ref. 229097; Map Sheet 2)

0– 9 ft	SHALE: light grey, very hard.

BMP 733 (Grid Ref. 237080; Map Sheet 2)

0– 6 ft	CLAY: medium brown, plastic.
6– 9 ft	CLAY: blue-grey and red; numerous pebbles.
9–12 ft	SHALE: light grey, very hard.

BMP 735 (Grid Ref. 268060; Map Sheet 2)

0– 3 ft	CLAY: dark brown.
3– 6 ft	SILTSTONE: light grey.
6– 9 ft	CLAY: light grey, sandy.
* 9–24 ft	SHALE: grey to brown.

BMP 740 (Grid Ref. 281048; Map Sheet 2)

0– 3 ft	CLAY: dark brown, plastic.
3– 9 ft	SAND: medium brown, very fine-grained.
9–36 ft	CLAY: medium brown, plastic; silty.

BMP 745 (Grid Ref. 225155; Map Sheet 2)

0– 6 ft	CLAY: medium brown to red, plastic; few pebbles.
6–12 ft	CLAY: medium brown, plastic.
12–27 ft	CLAY: medium brown to yellow-brown, plastic; sandy.
27–30 ft	CLAY: medium brown, plastic; numerous light yellow nodules.

Remarks: Water (30 ft).

BMP 747 (Grid Ref. 214151; Map Sheet 2)

0– 6 ft	CLAY: brown, sandy.
6– 9 ft	CLAY: blue-grey and red, plastic.
9–12 ft	CLAY: medium brown, plastic.
12–24 ft	CLAY: red, plastic; sandy.
24–30 ft	CLAY: yellow-brown, plastic; sandy.

Remarks: Water (30 ft).

BMP 749 (Grid Ref. 197148; Map Sheet 2)

0– 9 ft	SHALE: medium brown; numerous small carbonaceous fragments and plant fossil fragments.
9–15 ft	SHALE: white; few small granules.
15–24 ft	SHALE: red to purplish, hard.
24–30 ft	CLAY: dark grey to black, plastic; carbonaceous in part.
30–33 ft	CLAY: white to light yellow, plastic.
33–36 ft	CLAY: black, plastic.

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* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 753 (Grid Ref. 198157; Map Sheet 2)

	0– 6 ft	CLAY: medium to dark brown, plastic.
	6–12 ft	CLAY: medium brown, plastic; occasional small basalt pebbles.
	12–21 ft	CLAY: light grey to light brown, plastic.
	21–30 ft	CLAY: medium brown, plastic.
	30–36 ft	CLAY: red, plastic.

BMP 765 (Grid Ref. 270069; Map Sheet 2)

	0– 6 ft	CLAY: medium brown, sandy.
	6–12 ft	SHALE: light grey to light brown.
	12–24 ft	SHALE: dark grey to black.

BMP 768 (Grid Ref. 284154; Map Sheet 2)

	0–18 ft	SANDSTONE: light grey to brown, coarse-grained; numerous small pebbles.
	18–24 ft	SHALE: light grey and red-brown.

BMP 770 (Grid Ref. 284158; Map Sheet 2)

	0–18 ft	SANDSTONE: light grey, medium-grained, decomposed.
	18–30 ft	SHALE: grey and brown.

BMP 773 (Grid Ref. 372192; Map Sheet 2)

	0–24 ft	CLAY: medium brown, plastic.
	24–30 ft	CLAY: medium brown, plastic; numerous pebbles.

BMP 776 (Grid Ref. 416192; Map Sheet 2)

	0–27 ft	SILT: medium brown.

BMP 783 (Grid Ref. 385124; Map Sheet 2)

	0– 3 ft	SHALE: brown and black; highly carbonaceous.
*	3– 6 ft	SHALE: light brown and white.
*	6–15 ft	SHALE: dark grey to black; highly fossiliferous; highly carbonaceous.
	15–21 ft	SHALE: medium to dark grey, fossiliferous; coaly in part.

BMP 785 (Grid Ref. 332146; Map Sheet 2)

	0–12 ft	SHALE: light grey to light brown.
	12–15 ft	SHALE: yellow-brown.
	15–18 ft	SHALE: medium brown.
	18–24 ft	SHALE: light grey to medium brown.

BMP 786 (Grid Ref. 312149; Map Sheet 2)

*	0–12 ft	SHALE: light brown, decomposed.

Logs by: N. A. H. Simmonds

BMP 838 (Grid Ref. 397475; Map Sheet 4)

	0– 0+ ft	LOAM: sandy passing (0–3 ft) into
	0+–6+ ft	CLAY: grey, plastic, sandy passing (6–9 ft) into
	6+– 9 ft	CLAY: white, silty.
	9–12 ft	CLAY: light grey and brown, silty.
	12–18 ft	SAND: grey and yellow-brown, clayey.
	Remarks: Water (18 ft).	

BMP 842 (Grid Ref. 398480; Map Sheet 4)

	0– 6 ft	CLAY: dark grey, plastic.
*	6– 9 ft	CLAY: dark grey, sandy.
*	9–12 ft	CLAY: grey and brown mottled, plastic; sandy.
	12–24 ft	SAND: light grey, coarse-grained, clayey.
	24–33 ft	SAND: brown, coarse-grained, clayey (decomposed GRANITE).

27. Minor Clay Occurrences—continued

BMP 844 (Grid Ref. 397484; Map Sheet 4)

*	0– 9 ft	CLAY: light brown, sandy, plastic.
*	9–12 ft	CLAY: dark grey, plastic; sandy at base.
	*12–30 ft	CLAY: light brown, sandy (coarse-grained).
	Remarks: Water (30 ft).	

BMP 845 (Grid Ref. 398485; Map Sheet 4)

	0– 3 ft	CLAY: light brown.
*	3– 6 ft	CLAY: light brown, sandy.
*	6–15 ft	CLAY: dark grey, plastic, slightly sandy, 12–15 ft.
*	15–18 ft	CLAY: light grey, sandy.
*	18–27 ft	CLAY: light grey, plastic; sandy.
	*27–42 ft	CLAY: light brown, plastic; sandy.
	Remarks: Water (21 ft).	

BMP 846 (Grid Ref. 395485; Map Sheet 4)

	0– 3 ft	CLAY: yellow-brown, plastic.
*	3– 6+ ft	CLAY: medium brown, plastic, sandy passing (6–9 ft) into
*	6+–12 ft	CLAY: grey, plastic, sandy.
*	12–18 ft	CLAY: light grey, sandy; GRAVEL at 17 ft.
*	18–24 ft	CLAY: light brown, sandy.
*	24–30 ft	CLAY: medium brown, plastic, sandy.
*	30–36 ft	CLAY: light brown, sandy.
	Remarks: Water (27–30 ft).	

BMP 847 (Grid Ref. 394483; Map Sheet 4)

	0– 3 ft	LOAM: clayey.
	3–15+ ft	CLAY: medium brown, plastic; sandy passing (15–18 ft) into
	15+–18 ft	CLAY: grey, sandy.
	18–36 ft	CLAY: light brown, plastic, sandy.
	Remarks: Water (24 ft).	

BMP 850 (Grid Ref. 381497; Map Sheet 4)

	0– 3 ft	SILT.
*	3– 6 ft	CLAY: light brown, plastic when wet, sandy.
*	6–12 ft	CLAY: light brown, plastic when wet, gravelly.
	12–18+ ft	CLAY: medium brown, plastic when wet, gravelly passing (18–21 ft) into
*	18+–27 ft	CLAY: dark grey, plastic, slightly sandy.
*	27–30 ft	CLAY: dark grey and light brown, plastic; with few pebbles.

BMP 854 (Grid Ref. 379492; Map Sheet 4)

	0– 3 ft	LOAM: light brown.
*	3– 6 ft	CLAY: light brown; sandy and gravelly.
*	6–15 ft	CLAY: red to light grey, sandy; little gravel.
	15–15+ ft	GRANITE: hard, decomposed.

BMP 855 (Grid Ref. 377489; Map Sheet 4)

	0– 3 ft	LOAM: brown, clayey.
*	3– 6 ft	CLAY: red, plastic when wet.
*	6– 9 ft	CLAY: red and grey, slightly sandy.
*	9–18 ft	CLAY: light brown and grey, slightly sandy.
*	18–24 ft	CLAY: light brown, slightly sandy; with gravel.
	24–36 ft	GRAVEL: clayey.

BMP 869 (Grid Ref. 356486; Map Sheet 4)

	0– 3 ft	LOAM: light brown, clayey.
*	3– 9 ft	CLAY: light brown and grey, sericitic; slightly sandy, 6–9 ft.
*	9–15 ft	CLAY: medium grey and brown, slightly sandy.
	15–15+ ft	GRAVEL

* For results of firing tests, see Table IX.

TABLE VIII—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN CLAY DEPOSITS—*continued*

27. Minor Clay Occurrences—continued

BMP 882 (Grid Ref. 423483; Map Sheet 4)

	0– 3 ft	SOIL.
	3– 6 ft	SAND: medium brown, clayey in part.
*	6–12 ft	CLAY: dark brown, sandy.
*	12–15 ft	CLAY: medium brown to dark grey, sandy.
*	15–18 ft	CLAY: dark grey, very sandy.
	18–24 ft	SAND: light grey and medium brown, clayey.
	24–30 ft	CLAY: green-grey, sandy.
	30–36 ft	CLAY: light grey, sandy.

Remarks: Hole stopped on boulder.

BMP 883 (Grid Ref. 423486; Map Sheet 4)

0– 3 ft	SILT.
3– 6 ft	CLAY: light to medium brown, sandy.
6– 9+ ft	CLAY: light brown, dry and hard; light grey when wet
	passing (9–12 ft) into
9+–12 ft	CLAY: dark grey to brown, slightly sandy.
12–15 ft	CLAY: light to medium brown, sandy.
15–21 ft	CLAY: light brown, slightly sandy to very pale grey, plastic.
21–24 ft	CLAY: light brown, sandy.
24–30 ft	GRANITE: decomposed, hard.

Remarks: Water (21–24 ft).

BMP 884 (Grid Ref. 391420; Map Sheet 4)

	0– 3 ft	LOAM: medium brown, sandy.
*	3– 6 ft	CLAY: blue-grey, plastic.
*	6– 9 ft	CLAY: medium grey, plastic, silty.
*	9–15 ft	CLAY: medium brown, plastic, silty.
	15–18 ft	CLAY: medium brown, sandy.
	18–21 ft	CLAY: sandy.
	21–24 ft	GRANITE: decomposed.

Remarks: Water (21 ft).

BMP 890 (Grid Ref. 777255; Map Sheet 3)

0– 6 ft	TUFF: decomposed; clayey in part at top.

27. Minor Clay Occurrences—continued

Logs by: J. W. Laycock

BMP 977 (Grid Ref. 716003; Map Sheet 1)

0– 3 ft	CLAY: brown, plastic.
3– 6 ft	SHALE: light brown, hard.
6– 9 ft	CLAY: light brown, plastic.
9–12 ft	CLAY: red-brown, plastic.
12–27 ft	CLAY: light to medium brown, plastic.

BMP 1032 (Grid Ref. 934290; Map Sheet 3)

0–18 ft	CLAY: medium grey to brown, plastic.
18–30 ft	CLAY: medium brown, plastic.

BMP 1033 (Grid Ref. 933297; Map Sheet 3)

0–15 ft	CLAY: medium brown, plastic.
15–21 ft	CLAY: medium grey, plastic.
21–36 ft	CLAY: medium brown, plastic.

BMP 1041 (Grid Ref. 917267; Map Sheet 3)

0– 3 ft	LOAM: grey, sandy.
3– 6 ft	CLAY: grey and brown, plastic, sandy (fine-grained).
6–15 ft	CLAY: light grey, plastic.
15–27 ft	CLAY: red-brown, plastic.
27–30 ft	SILTSTONE: light grey, decomposed.

BMP 1063 (Grid Ref. 569663; Map Sheet 5)

0–24 ft	CLAY: medium brown, plastic.
24–30 ft	CLAY: dark green, plastic.

BMP 1085 (Grid Ref. 589632; Map Sheet 5)

0–12 ft	CLAY: medium brown, plastic.

Remarks: Water (12 ft).

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* For results of firing tests, see Table IX.

TABLE IX

REPORTS OF FIRING TESTS ON CLAY SAMPLES

1. Samples from Deposit Cl 2 - Darra

Analyst: A. Young, Government Chemical Laboratory, Brisbane

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								Remarks
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating		
BMP 1691 (14-17')	buff	15	good strength, plastic	pale terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1691 (17-26')	buff	15	good strength, plastic	pale terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	brown	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1691 (26-29')	grey	16	good strength, plastic	pale pink	2	medium strength, partially sintered	pale pink	0	medium strength, partially sintered	pale pink	0	medium strength, partially sintered	pale pink	0	medium strength, partially vitrified	pale pink	6	medium strength, partially vitrified	ND	X	-	X	X	X	-	-	-	-	
BMP 1691 (29-32')	buff	15	good strength, plastic	pink	2	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	brown	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1691 (32-36')	buff	15	weak, non-plastic	terra cotta	0	weak, partially sintered	terra cotta	0	weak, partially sintered	terra cotta	0	weak, fully sintered	terra cotta	0	weak, partially vitrified	terra cotta	0	weak, fully vitrified	ND	-	-	-	-	-	-	-	-	
BMP 1691 (36-44')	buff	15	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1692 (5-8')	pale pink	18	good strength, plastic	terra cotta	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	3	dense and tough, partially vitrified	pink	2	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1692 (8-14')	pale pink	20	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	1	dense and tough, partially vitrified	buff	3	dense and tough, fully vitrified	ND	X	X	X	X	X	-	-	-	
BMP 1692 (14-21')	pale pink	18	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	dense and tough, fully sintered	pink	2	excellent strength, partially vitrified	pink	2	dense and tough, fully vitrified	ND	X	X	X	-	X	-	-	-	
BMP 1693 (8-17')	buff	18	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	buff	0	dense and tough, fully vitrified	ND	X	X	X	X	X	-	-	-	

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1. Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 1695 (8-14')	pink, brown efflor-escence	10	good strength, plastic	pink	0	weak, slightly sintered	pink	0	weak, slightly sintered	pink	0	good strength, partially sintered	pink	0	weak, fully sintered	pink	5	weak, fully sintered	ND	X	-	X	X	-	-	-	-
BMP 1695 (14-23')	buff	10	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	buff	0	good strength, fully vitrified	ND	-	-	-	-	-	-	-	-
BMP 1696 (5-11')	pale pink	16	good strength, plastic	pink	2	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	2	excellent strength, partially vitrified	brown	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1696 (11-17')	pink	10	weak, non-plastic	terra cotta	0	weak, partially sintered	terra cotta	0	weak, partially sintered	terra cotta	0	weak, partially sintered	terra cotta	0	weak, partially sintered	dark terra cotta	0	weak, partially sintered	ND	-	-	-	-	-	-	-	-
BMP 1697 (5-11')	pale pink	17	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	buff	0	good strength, fully sintered	buff	0	excellent strength, partially vitrified	buff	0	dense and tough, fully vitrified	ND	X	X	X	X	X	-	-	-
BMP 1697 (11-17')	pale pink	18	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	4	dense and tough, fully sintered	pink	0	excellent strength, partially vitrified	pink	0	dense and tough, fully vitrified	ND	X	X	X	X	X	-	-	-
BMP 1697 (17-23')	pale pink	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	pink	2	dense and tough, fully sintered	pink	0	excellent strength, partially vitrified	buff	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1697 (23-29')	pale pink	18	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	pink	0	good strength, fully sintered	buff	0	good strength, partially vitrified	buff	0	dense and tough, fully vitrified	ND	X	X	X	X	X	-	-	-
BMP 1703 (5-11')	off-white	15	good strength, plastic	pale terra cotta	1	medium strength, partially sintered	pale terra cotta	0	medium strength, partially sintered	pale terra cotta	0	medium strength, partially sintered	pale terra cotta	0	good strength, partially vitrified	pale terra cotta	4	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1703 (11-20')	pink	15	good strength, plastic	pale terra cotta	0	medium strength, partially sintered	pale terra cotta	0	good strength, partially sintered	pale terra cotta	0	good strength, fully sintered	pale terra cotta	0	good strength, partially vitrified	pale terra cotta	3	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX..... continued

1. Samples from Deposit Cl 2 ..... continued

Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 1703 (20-26')	pink	20	good strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	1	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	2	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1703 (26-32')	pink	20	good strength, plastic	terra cotta	0	medium strength, partially sintered	pale terra cotta	2	good strength, partially sintered	terra cotta	0	good strength, fully sintered	pale terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1704 (17-26')	off-white	18	good strength, plastic	pale terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, partially sintered	pale terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	pale terra cotta	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1704 (26-32')	brown	20	good strength, plastic	terra cotta	1	good strength, partially sintered	terra cotta	4	good strength, fully sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	2	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1705 (2-11')	brown	18	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, fully sintered	terra cotta	0	excellent strength, fully sintered	terra cotta	0	excellent strength, partially vitrified	terra cotta	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1705 (11-17')	buff	17	good strength, plastic	pale terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, fully sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	1	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1705 (17-20')	off-white	17	good strength, plastic	pale terra cotta	0	good strength, partially sintered	pale terra cotta	3	good strength, fully sintered	pale terra cotta	0	good strength, fully sintered	pale terra cotta	0	good strength, partially vitrified	pale terra cotta	1	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1705' (20-23')	off-white	18	good strength, plastic	pale terra cotta	0	good strength, partially sintered	pale terra cotta	2	good strength, fully sintered	terra cotta	0	excellent strength, fully sintered	terra cotta	0	excellent strength, partially vitrified	terra cotta	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1708 (2-8')	terra cotta	17	good strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, partially vitrified	pink	6	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-
BMP 1708 (8-11')	terra cotta	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	5	excellent strength, partially vitrified	pink	6	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-
BMP 1708 (11-14')	brown	20	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	good strength, partially sintered	pale pink	1	good strength, fully sintered	pale pink	0	good strength, partially vitrified	pale pink	2	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1. Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 1708 (14-17')	dark pink	19	good strength, plastic	pale pink	2	good strength, partially sintered	pale pink	1	good strength, fully sintered	pale pink	0	excellent strength, partially vitrified	brown	2	excellent strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1708 (17-20')	dark pink	11	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	2	good strength, fully sintered	pale pink	2	excellent strength, partially vitrified	brown	0	excellent strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1708 (20-23')	dark pink	11	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	1	good strength, fully sintered	pale pink	1	excellent strength; partially vitrified	brown	0	excellent strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1708 (23-26')	dark brown	12	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	good strength, fully sintered	buff	0	good strength, partially vitrified	brown	0	good strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1708 (26-29')	brown	11	good strength, plastic	pale buff	0	medium strength, partially sintered	pale buff	0	medium strength, partially sintered	pale buff	0	medium strength, partially sintered	pale buff	0	medium strength, partially vitrified	pale buff	2	medium strength, partially vitrified	ND	X	-	X	X	X	-	-	-
BMP 1709 (8-11')	dark brown	12	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	2	good strength, partially vitrified	terra cotta	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1709 (11-17')	dark pink	15	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	good strength, fully sintered	pale pink	2	excellent strength, partially vitrified	brown	2	excellent strength, fully vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1709 (17-23')	dark pink	19	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	excellent strength, fully sintered	pale pink	0	excellent strength, partially vitrified	brown	0	excellent strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1709 (23-29')	dark pink	19	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	excellent strength, fully sintered	pale pink	0	excellent strength, partially vitrified	brown	0	excellent strength, partially vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1709 (29-32')	dark pink	25	good strength, plastic	pink	0	good strength, partially sintered	pink	0	excellent strength, fully sintered	pink	1	excellent strength, partially vitrified	brown	1	excellent strength, fully vitrified	brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1. Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								Remarks
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	
BMP 1710 (2-8')	dark brown	15	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	1	good strength, fully vitrified	terra cotta	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1710 (8-11')	dark brown	14	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, fully sintered	terra cotta	0	excellent strength, partially vitrified	terra cotta	1	excellent strength, fully vitrified	terra cotta	2	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1710 (11-17')	dark pink	18	good strength, plastic	pink	0	good strength, partially sintered	pink	2	good strength, fully sintered	buff	2	excellent strength, partially vitrified	brown	2	excellent strength, fully vitrified	dark brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1710 (17-23')	terra cotta	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, fully sintered	terra cotta	2	excellent strength, partially vitrified	brown	1	excellent strength, fully vitrified	dark brown	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1710 (23-29')	buff	12	good strength, plastic	pink	0	good strength, partially sintered	buff	0	good strength, partially sintered	buff	3	good strength, partially sintered	buff	0	good strength, partially vitrified	buff	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1711 (2-8')	pink	20	good strength, plastic	pink	0	good strength, partially sintered	pink	0	excellent strength, partially sintered	buff	2	excellent strength, fully sintered	buff	2	excellent strength, partially vitrified	brown	1	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1711 (8-14')	terra cotta	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	excellent strength, fully sintered	terra cotta	2	excellent strength, partially vitrified	brown	2	excellent strength, partially vitrified	dark brown	1	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1711 (14-20')	terra cotta	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	excellent strength, fully sintered	pink	2	excellent strength, partially vitrified	brown	0	excellent strength, partially vitrified	buff	1	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1711 (20-26')	dark brown	14	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	excellent strength, fully sintered	pink	0	excellent strength, partially vitrified	brown	0	excellent strength, partially vitrified	brown	1	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1711 (26-30')	pink	14	good strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	2	good strength, fully sintered	grey	0	good strength, partially vitrified	grey	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1712 (2-8')	pink	16	good strength, plastic	pale terra cotta	0	good strength, partially sintered	pale terra cotta	0	excellent strength, partially sintered	pale terra cotta	0	dense and tough, fully sintered	grey	0	dense and tough, partially vitrified	grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1. Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								Remarks
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	
BMP 1712 (8-14')	terra cotta	20	good strength, plastic	pale terra cotta	2	good strength, partially sintered	pale terra cotta	2	good strength, partially sintered	pink	0	good strength, fully sintered	pink	6	excellent strength, partially vitrified	pink	7	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-	
BMP 1712 (14-20')	terra cotta	18	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	1	good strength, fully sintered	pink	5	excellent strength, partially vitrified	pink	6	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-	
BMP 1712 (20-26')	brown	20	good strength, plastic	pale terra cotta	0	medium strength, partially sintered	pale terra cotta	0	good strength, partially sintered	pale terra cotta	1	good strength, fully sintered	pale terra cotta	5	good strength, partially vitrified	pale terra cotta	0	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-	
BMP 1712 (26-32')	brown	17	good strength, plastic	pale terra cotta	3	weak, slightly sintered	pale terra cotta	0	good strength, partially sintered	pale terra cotta	0	good strength, fully sintered	pale terra cotta	0	good strength, partially vitrified	pale terra cotta	8	excellent strength, partially vitrified	ND	X	-	X	X	-	-	-	-	
BMP 1712 (32-38')	brown	16	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	excellent strength, partially sintered	terra cotta	0	dense and tough, fully sintered	grey	0	dense and tough, partially vitrified	grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1714 (5-11')	terra cotta	15	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	5	good strength, partially sintered	terra cotta	0	good strength, fully sintered	brown	0	good strength, partially vitrified	brown	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1714 (11-17')	terra cotta	10	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	pale terra cotta	0	good strength, fully sintered	brown	0	good strength, partially vitrified	brown	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1715 (14-20')	off-white	8	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pale terra cotta	0	good strength, fully sintered	brown	0	good strength, partially vitrified	brown	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1716 (5-11')	terra cotta	9	good strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, fully sintered	terra cotta	0	medium strength, partially vitrified	terra cotta	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-	
BMP 1716 (11-17')	off-white	10	good strength, plastic	pink	0	medium strength, partially sintered	pink	0	medium strength, partially sintered	terra cotta	0	medium strength, fully sintered	pale terra cotta	0	medium strength, partially vitrified	brown	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-	

* Logs of drillholes from which samples were taken are given in Table VIII.

ND not determined.

TABLE IX.....continued

1.

Samples from Deposit C1 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C.			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 1717 (11-14')	pink	13	good strength, plastic	pink	0	good strength, partially sintered	pink	2	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	grey	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1717 (14-17')	pink	15	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	grey	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1717 (17-23')	pink	15	good strength, plastic	pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	grey	0	excellent strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1717 (23-29')	pink	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	2	excellent strength, partially sintered	terra cotta	0	dense and tough, fully sintered	grey	0	dense and tough, partially vitrified	grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1718 (11-14')	brown	10	good strength, plastic	terra cotta	1	good strength, partially sintered	terra cotta	1	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, fully sintered	grey	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1718 (14-20')	brown	11	good strength, plastic	pale terra cotta	0	good strength, partially sintered	pale terra cotta	0	good strength, partially sintered	pale terra cotta	0	excellent strength, fully sintered	pale terra cotta	0	excellent strength, fully sintered	pale grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1718 (20-26')	brown	14	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	excellent strength, partially sintered	pale pink	0	excellent strength, fully sintered	pale grey	0	dense and tough, fully sintered	pale grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1718 (26-32')	brown	15	good strength, plastic	pink	0	good strength, partially sintered	pink	0	excellent strength, partially sintered	pink	0	excellent strength, fully sintered	pink	0	dense and fough, fully sintered	pink	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1719 (5-11')	off-white	10	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	excellent strength, partially sintered	pale pink	0	excellent strength, fully sintered	grey	0	dense and tough, fully sintered	grey	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1719 (11-17')	off-white	13	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	good strength, partially sintered	pale pink	0	good strength, fully sintered	pale pink	0	good strength, partially vitrified	pale pink	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1. Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 1723 (5-11')	pale pink	15	good strength, plastic	pale pink	1	good strength, partially sintered	pink	0	excellent strength, partially sintered	pink	0	dense and tough, fully sintered	terra cotta	0	dense and tough, partially vitrified	terra cotta	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1723 (11-17')	pale pink	13	good strength, plastic	pale pink	0	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	pink	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1723 (17-23')	pale pink	17	good strength, plastic	pale pink	1	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	good strength, fully sintered	pink	0	good strength, partially vitrified	pink	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1723 (23-29')	light brown	12	good strength, plastic	pale pink	1	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	excellent strength, fully sintered	pink	0	dense and tough, partially vitrified	pink	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1725 (1-2')	dark brown	20	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	excellent strength, fully sintered	terra cotta	0	dense and tough, partially vitrified	terra cotta	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1725 (2-8')	dark brown	13	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1725 (8-14')	buff	10	medium strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1725 (14-20')	buff	16	good strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1725 (20-26')	off-white	10	good strength, plastic	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, partially sintered	terra cotta	0	good strength, fully sintered	terra cotta	0	good strength, partially vitrified	terra cotta	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1726 (8-11')	brown	5	good strength, plastic	pink	1	good strength, partially sintered	pink	0	good strength, partially sintered	pink	0	excellent strength, fully sintered	pink	0	excellent strength, partially vitrified	pink	0	dense and tough, fully vitrified	ND	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.

TABLE IX.....continued

1.

Samples from Deposit Cl 2 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								Remarks
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating		
BMP 1726 (17-20')	brown	5	medium strength, plastic	pink	0	medium strength, partially sintered	pink	0	medium strength, partially sintered	pink	0	medium strength, fully sintered	pink	0	medium strength, partially vitrified	pink	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1726 (20-26')	brown	8	medium strength, plastic	pink	0	medium strength, partially sintered	pink	0	medium strength, partially sintered	pink	0	medium strength, fully sintered	pink	0	medium strength, partially vitrified	pink	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1727 (14-20')	off-white	9	medium strength, plastic	pink	0	medium strength, partially sintered	pink	0	medium strength, partially sintered	pink	0	medium strength, fully sintered	pink	0	medium strength, partially vitrified	pink	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1728 (14-17')	pink	8	medium strength, plastic	pink	0	medium strength, partially sintered	pink	0	medium strength, partially sintered	pink	0	medium strength, fully sintered	pink	0	medium strength, partially vitrified	pink	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1728 (17-23')	pink	10	good strength, plastic	pale pink	0	good strength, partially sintered	pale pink	0	good strength, partially sintered	pale pink	0	good strength, fully sintered	pale pink	0	good strength, partially vitrified	pale pink	0	good strength, fully vitrified	ND	X	X	X	X	-	-	-	-
BMP 1728 (23-29')	brown	10	medium strength, plastic	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, partially sintered	terra cotta	0	medium strength, fully sintered	terra cotta	0	medium strength, partially vitrified	terra cotta	0	medium strength, fully vitrified	ND	X	X	X	X	-	-	-	-

2.

Samples from Deposit Cl 3 - Rocklea

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 639 (0-15')	brown	17.0	good strength, plastic	terra cotta	5.0	good strength, partially sintered	terra cotta	8.5	good strength, partially sintered	terra cotta	11.0	excellent strength, fully sintered	brown	12.0	dense and tough, partially vitrified	brick red	14.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-	2
BMP 639 (15-30')	brown	17.0	good strength, plastic	terra cotta, trace white efflor-escence	2.0	good strength, partially sintered	terra cotta, trace white efflor-escence	3.5	good strength, partially sintered	brown, white efflor-escence	6.5	good strength, partially sintered	brown, white efflor-escence	7.5	excellent strength, partially vitrified	dark brown, efflor-escence slightly fused	3.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-	

* Logs of drillholes from which samples were taken are given in Table VIII.
ND Not determined.
2. Would be best to admix grog sand or siliceous clay to reduce shrinkage.

TABLE IX.....continued

2. Samples from Deposit Cl 3 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 640 (0-12')	dark grey	16.0	good strength, plastic	light brown	1.0	good strength, partially sintered	brown, efflor-escence	2.0	good strength, partially sintered	brown, efflor-escence	6.5	excellent strength, partially sintered	light brown	9.5	excellent strength, fully sintered	warm brown	4.5	dense and tough, partially vitrified, fused blebs through ground-mass	-	X	X	X	X	-	-	-	-
BMP 631 (12-27')	grey	11.0	good strength, semi-plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	excellent strength, partially sintered	terra cotta	5.0	excellent strength, partially sintered	brown	7.5	dense and tough, partially vitrified	brown	8.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 632 (0-27')	grey	16.0	good strength, non-plastic	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	4.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	brown	8.5	excellent strength, partially vitrified	brown	10.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 648 (0-18')	grey	18.0	good strength, plastic	brown, efflor-escence	0.2	good strength, partially sintered	brown, efflor-escence	1.0	good strength, partially sintered	brown, dark efflor-escence	4.0	excellent strength, partially sintered	light brown, brown efflor-escence	9.0	dense and tough, partially vitrified	brown, brown efflor-escence	11.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	2

3. Samples from Deposit Cl 4 - Oxley

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

4. Samples from Deposit Cl 5 - Acacia Ridge

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 317 (6-24')	pale brown	8.0	good strength, plastic	pink	3.0	good strength, partially sintered	pink	4.0	good strength, partially sintered	brown	8.0	good strength, partially sintered	terra cotta	9.0	excellent strength, fully sintered	dark brown	11.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
2. Would be best to admix grog sand or siliceous clay to reduce shrinkage.

TABLE IX.....continued

4. Samples from Deposit Cl 5 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 318 (9-27')	pale pink	10.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	4.0	excellent strength, partially sintered	terra cotta	8.5	excellent strength, fully sintered	terra cotta	11.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 622 (9-24')	brown-red	16.0	good strength, plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	4.0	good strength, partially sintered	brown	5.0	good strength, partially sintered	dark brown	9.0	good strength, partially sintered	dark brown	10.0	good strength, partially vitrified	-	X	-	-	-	-	-	-	-
NS 3 (10-47'10")	grey	12.5	good strength, semi-plastic	pale brown	1.0	good strength, partially sintered	light brown	1.5	good strength, partially sintered	light brown	4.5	good strength, partially sintered	brown	6.0	good strength, fully sintered	brown	7.5	excellent strength, fully vitrified	-	X	X	X	X	-	-	-	-
NS 3 (47'10"-91'11")	grey	19.0	good strength, plastic	brown	1.0	good strength, partially sintered	brown	2.0	good strength, partially sintered, tendency to crack	brown	3.0	good strength, partially sintered	brown	7.0	excellent strength, fully sintered	brown	4.5	dense and tough, fully vitrified, fused edges	-	X	X	X	X	-	-	-	1
NS 3 (91'11"-109' 8")	stone	12.5	good strength, semi-plastic	pale brown	0.5	good strength, partially sintered	pale brown	1.0	good strength, partially sintered	cream	1.5	good strength, partially sintered	cream	2.5	good strength, fully sintered	brown	3.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

5. Samples from Deposit Cl 6 - Eight Mile Plains

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 280 (0-12')	cream	11.0	good strength, plastic	pale brown	0.5	good strength, partially sintered	pale brown	2.0	good strength, partially sintered	very pale pink	6.0	good strength, partially sintered	cream	7.5	excellent strength, partially sintered	cream	10.0	excellent strength, fully sintered	-	X	X	X	X	-	-	-	-
BMP 287 (6-12')	pale brown	9.0	good strength, plastic	pale terra cotta	0.5	good strength, partially sintered	pale terra cotta	1.0	good strength, partially sintered	very pale terra cotta	1.5	excellent strength, partially sintered	dark cream	2.0	excellent strength, partially sintered	cream	4.5	dense and tough, fully sintered	-	X	X	X	X	-	-	-	-
BMP 288 (3-9')	pink-brown	17.0	good strength, plastic	brown	0.2	good strength, partially sintered	brown	1.0	good strength, partially sintered	brown	3.0	excellent strength, fully sintered	dark brown	4.0	dense and tough, partially vitrified	brown	1.0	dense and tough, fully vitrified, slightly bloated	-	X	X	-	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
1. Care would have to be used in drying and firing to prevent cracking.

TABLE IX.....continued

5. Samples from Deposit Cl 6..... continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 288 (9-18')	grey	15.0	medium strength, plastic	buff	4.0	good strength, partially sintered	buff	5.0	excellent strength, partially sintered	cream	6.0	excellent strength, partially sintered	light khaki	7.5	dense and tough, fully sintered	pale brown	9.0	dense and tough, partially vitrified	-	X	X	-	X	-	-	-	
BMP 288 (18-30')	grey	15.0	medium, cracked on drying, plastic	buff	1.0	good strength, partially sintered	buff	3.0	excellent strength, partially sintered	cream	4.0	excellent strength, partially sintered	light khaki	5.0	dense and tough, partially vitrified	pale brown	6.5	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	2
BMP 289 (6-15')	pink	13.0	good strength, plastic	pink	1.0	good strength, partially sintered	pink	1.5	good strength, partially sintered	pink	2.0	good strength, partially sintered	dark brown	9.0	good strength, fully sintered	brown	13.0	good strength, partially vitrified	-	X	-	-	-	-	-	-	
BMP 289 (15-18')	pale brown	12.0	good strength, plastic	pink	1.0	good strength, partially sintered	pink	2.0	good strength, partially sintered	pink	4.0	good strength, partially sintered	brown	15.0	good strength, fully sintered	brown	16.0	good strength, partially vitrified	-	X	X	-	X	-	-	-	
BMP 289 (18-33')	light brown	14.0	good strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	excellent strength, partially sintered	terra cotta	6.0	excellent strength, partially sintered	choco-late	11.0	dense and tough, partially vitrified	brown-red	13.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	

Samples from Deposit Cl 7 - Eight Mile Plains

6. Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 229 (0-6')	brown	13.0	good strength, plastic	terra cotta	3.0	good strength, partially sintered	terra cotta	4.0	good strength, partially sintered	terra cotta	5.0	excellent strength, partially sintered	brown	8.5	dense and tough, partially vitrified	dark brown	10.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	
BMP 229 (6-15')	white	10.0	weak, plastic	white, pink tint	0.1	weak, trace of sinter	white, trace of pink	0.2	weak, trace of sinter	white, trace of pink	0.5	fair strength, partially sintered	pale cream	0.7	medium strength, partially sintered	cream	3.0	good strength, partially sintered	yellow	-	-	-	-	-	-	-	
BMP 229 (15-21')	pale pink	13.0	fair strength, plastic	pale pink	1.0	fair strength, partially sintered	pale pink	2.0	fair strength, partially sintered	pale pink	2.0	fair strength, partially sintered	cream	6.0	good strength, fully sintered	cream	10.0	good strength, partially vitrified	yellow	X	-	-	-	-	-	-	

* Logs of drillholes from which samples were taken are given in Table VIII.

2. Possibly could be used for tiles or pipes or common pottery if blended with other clays, grog or sand.

TABLE IX.....continued

Samples from Deposit Cl 7.....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 230 (0-15')	yellow	10.0	good strength, semi-plastic	pale terra cotta	0.2	fair strength, partially sintered	pale terra cotta	0.5	fair strength, partially sintered	pale terra cotta	0.7	fair strength, partially sintered	pale terra cotta	0.7	fair strength, partially sintered	terra cotta	2.0	medium strength, partially sintered	-	X	-	-	-	-	-	-	-
BMP 232 (0-15')	pink	14.0	good strength, semi-plastic	pale terra cotta	3.0	good strength, partially sintered	pale terra cotta	4.0	good strength, partially sintered	pale terra cotta	4.5	good strength, partially sintered	brown	8.5	excellent strength, fully sintered	brown	4.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	trace	-
BMP 232 (15-30')	pink	18.0	good strength, plastic	pink	1.0	good strength, partially sintered	pink	2.0	good strength, partially sintered	pink	2.5	excellent strength, partially sintered	brown	9.0	excellent strength, partially vitrified	dark brown	3.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	trace	-
BMP 233 (0-6')	brown	14.0	good strength, plastic	terra cotta	4.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	terra cotta	5.5	excellent strength, partially sintered	brown	12.0	dense and tough, partially vitrified	brick red	13.0	dense and tough, fully vitrified	-	X	-	-	X	-	-	-	-
BMP 236 (9-15')	khaki	11.0	good strength, semi-plastic	brown	2.0	medium strength, partially sintered	brown	3.0	good strength, partially sintered	brown	4.0	excellent strength, partially sintered	brown	10.0	dense and tough, fully sintered	brown	11.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 238 (0-9')	grey	15.0	excellent strength, semi-plastic	brown	1.0	fair strength, partially sintered	brown	2.0	medium strength, partially sintered	brown	5.0	good strength, fully sintered	dark brown	6.5	fused blebs through brick	black	—	semi-fused, some bloating	-	X	-	-	-	-	-	trace	-
BMP 238 (9-21')	khaki	15.0	good strength, plastic	terra cotta	6.0	medium strength, partially sintered	terra cotta	8.0	good strength, partially sintered	terra cotta	12.0	good strength, partially sintered	dark brown	13.0	excellent strength, fully sintered	terra cotta	4.0	fully vitrified, some bloating	-	X	X	-	-	-	-	trace	-
BMP 238 (21-30')	dark grey	17.0	good strength, plastic	pale pink	1.0	medium strength, partially sintered	pale pink	1.5	good strength, partially sintered	stone	2.0	good strength, partially sintered	brown stone	3.0	dense and tough, partially vitrified	brown and grey	+2.0	dense and tough, fully vitrified, some bloating	-	X	-	-	-	-	-	trace	-
BMP 240 (0-12')	pale brown	16.0	good strength, plastic	brown	3.0	fair strength, partially sintered	brown	4.0	fair strength, partially sintered	brown	4.5	fair strength, partially sintered	brown	11.0	medium strength, fully sintered	brown	13.0	medium strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 240 (12-18')	pale brown	12.0	good strength, plastic	brown	4.0	medium strength, partially sintered	brown	5.0	good strength, partially sintered	brown	9.0	good strength, partially sintered	terra cotta	11.0	excellent strength, fully sintered	brown	13.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX..... continued

6. Samples from Deposit Cl 7 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 241 (0-9')	red-brown	17.0	good strength, plastic	terra cotta	0.5	fair strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	brown	12.0	excellent strength, fully sintered	brown	14.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 241 (9-24')	brown	13.0	good strength, plastic	brown	4.0	fair strength, partially sintered	brown	4.5	good strength, partially sintered	brown	7.5	good strength, partially sintered	brown	11.0	excellent strength, fully sintered	brown	14.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 242 (6-15'; 18-21')	pale grey	16.0	good strength, plastic	pink	2.0	weak, slightly sintered	pink	3.5	fair strength, partially sintered	pink	4.0	fair strength, partially sintered	grey	13.0	medium strength, partially sintered	grey	15.0	good strength, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 242 (15-18')	off-white	16.0	good strength, plastic	stone	3.0	fair strength, partially sintered	stone	4.0	medium strength, partially sintered	stone	5.0	good strength, partially sintered	stone	11.0	excellent strength, partially vitrified	stone	12.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 242 (21-30')	brown	15.0	good strength, plastic	terra cotta	1.0	fair strength, partially sintered	terra cotta	2.0	medium strength, partially sintered	brown	4.0	good strength, partially sintered	dark brown	14.5	excellent strength, fully sintered	dark brown	13.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 243 (12-27')	red	10.0	fair strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	8.5	excellent strength, partially sintered	dark brown	9.0	dense and tough, fully sintered	dark brown	8.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 244 (6-24')	brown	9.0	good strength, semi-plastic	terra cotta	2.0	medium strength, partially sintered	terra cotta	4.0	good strength, partially sintered	terra cotta	8.5	good strength, partially sintered	dark brown	10.0	excellent strength, fully sintered	dark brown	7.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 245 (0-21')	dark red	11.5	good strength, non-plastic	terra cotta	2.5	fair strength, slightly sintered	terra cotta	3.0	medium strength, partially sintered	terra cotta	6.5	medium strength, partially sintered	terra cotta	12.0	medium strength, fully sintered	dark brown	13.0	good strength, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 245 (21-24')	brown	13.0	good strength, non-plastic	terra cotta	3.0	medium strength, slightly sintered	terra cotta	4.0	good strength, partially sintered	terra cotta	8.5	good strength, partially sintered	dark brown	14.0	excellent strength, fully sintered	brick-red	12.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drill holes from which samples were taken are given in Table VIII.

TABLE IX.....continued

Samples from Deposit Cl 7 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 246 (0-12')	dark brown	11.0	good strength, plastic	terra cotta, white blebs	7.0	medium strength, partially sintered	terra cotta, white blebs	8.0	medium strength, partially sintered	terra cotta	9.5	good strength, partially sintered	dark brown, fused blebs	7.0	good strength, partially vitrified	black	+3.0	semi-bloated, fused surface	-	X	-	-	-	-	-	semi	-
BMP 247 (0-12')	brown	15.0	good strength, plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	5.0	excellent strength, partially sintered	dark brown	4.0	dense and tough, fully sintered	black	4.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 249 (0-3')	brown	13.5	good strength, plastic	terra cotta	3.0	good strength, partially sintered	terra cotta	3.5	good strength, partially sintered	terra cotta	4.5	excellent strength, partially sintered	dark brown	6.5	dense and tough, fully sintered	dark brown	11.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 250 (0-18')	brick red	11.0	good strength, non-plastic	terra cotta	1.0	weak, slightly sintered	terra cotta	2.5	weak, slightly sintered	terra cotta	10.0	medium strength, partially sintered	dark brown	13.0	medium strength, partially sintered	dark brown	14.0	medium strength, fully sintered	-	-	-	-	-	-	-	-	-
BMP 250 (18-30')	brown-pink	13.0	good strength, plastic	terra cotta	1.0	medium strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	8.0	good strength, partially sintered	brown	12.0	excellent strength, fully sintered	dark brown	13.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 252 (0-18')	light brown	15.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	4.0	excellent strength, partially sintered	brick red	3.0	dense and tough, partially vitrified	brick red	2.0	dense and tough, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 252 (18-24')	light brown	12.0	good strength, plastic	terra cotta	1.0	medium strength, partially sintered	light brown	6.0	medium strength, partially sintered	terra cotta	8.0	medium strength, partially sintered	black	11.0	dense and tough, partially vitrified	black	4.0	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 268 (0-12')	brown	16.0	good strength, semi-plastic	terra cotta	2.0	weak, slightly sintered	terra cotta	3.0	medium strength, partially sintered	terra cotta	8.0	good strength, partially sintered	brown	8.0	excellent strength, partially vitrified	brick red	9.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 268 (12-27')	brown	15.0	good strength, plastic	terra cotta	3.0	weak, slightly sintered	terra cotta	5.0	good strength, partially sintered	terra cotta	6.5	good strength, fully sintered	grey-brown	8.5	excellent strength, partially vitrified	dark brown	3.0	dense and tough, fully vitrified, slight bloating	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

6. Samples from Deposit Cl 7 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 269 (0-12')	buff	13.0	good strength, plastic	buff	0.2	fair strength, slightly sintered	brown-stone	1.0	good strength, partially sintered	stone	2.0	excellent strength, partially sintered	stone	3.0	dense and tough, fully sintered	light brown	4.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 269 (12-21')	pale pink	16.0	good strength, plastic	pale brown	1.0	good strength, partially sintered	pale brown	2.0	good strength, partially sintered	buff, brown efflor-escence	4.0	excellent strength, partially sintered	buff, brown efflor-escence	7.0	dense and tough, partially vitrified	buff, dark brown efflor-escence	9.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	1
BMP 270 (6-18')	pale pink	15.0	good strength, plastic	pink	1.0	good strength partially sintered	pink	3.0	good strength, partially sintered	pink	4.0	good strength, partially sintered	brown	4.5	excellent strength, fully sintered	brown	5.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 270 (18-24')	pale grey	15.0	good strength, plastic	pink	3.0	good strength, partially sintered	pale pink	4.0	good strength, partially sintered	pale pink	5.0	excellent strength, partially sintered	stone	5.5	excellent strength, partially vitrified	stone	3.0	dense and tough, fully vitrified, very slight bloating	-	X	X	X	X	-	-	-	-
BMP 271 (0-6')	pale grey	10.0	good strength, semi-plastic	brown	1.0	good strength, partially sintered	brown	2.0	good strength, partially sintered	brown	6.0	excellent strength, partially sintered	dark terra cotta	9.0	dense and tough, fully sintered	dark terra cotta	8.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 272 (9-18')	buff	8.0	good strength, semi-plastic	light terra cotta	3.0	good strength, partially sintered	light terra cotta	4.0	good strength, partially sintered	terra cotta	5.0	good strength, cracked	brick red	14.0	good strength, cracked, fully sintered	brick red	9.0	good strength, cracked, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 272 (18-30')	cream	9.0	good strength, plastic	brown	2.0	good strength, partially sintered	brown	2.0	good strength, partially sintered	dark brown	6.0	good strength, partially sintered	dark brown	8.0	excellent strength, partially sintered	very dark brown	13.0	excellent strength, fully sintered	-	X	X	-	-	X	?[2]	-	-

7. Samples from Deposit Cl 8 - Rochedale

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 219 (0-9')	brown	9.0	fair strength, semi-plastic	terra cotta	0.2	weak, trace sinter	terra cotta	0.4	weak, trace sinter	terra cotta	0.6	weak, trace sinter	terra cotta	0.8	weak, slightly sintered	brick red	1.0	medium strength, partially sintered	trace yellow	-	-	-	-	-	-	-	3

* Logs of drillholes from which samples were taken are given in Table VIII.

1. Actual kiln tests would have to be made to determine the influence of the efflorescence which appears during burning.
2. Not suitable if opaque glazes used.
3. May be used if blended with other clays.

TABLE IX.....continued

Samples from Deposit Cl 8 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 219 (9-24')	brown	11.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	excellent strength, partially sintered	terra cotta	3.0	excellent strength, fully sintered	dark brick red	5.0	dense and tough, slightly vitrified	dark brown	6.5	dense and tough, partially vitrified	-	X	X	-	X	-	-	-	
BMP 220 (0-9')	brick red	11.0	good strength, semi-plastic	terra cotta	0.2	fair strength	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	medium strength, fully sintered	brown	3.0	good strength, slightly vitrified	brick red	4.0	excellent strength, partially vitrified	trace yellow	X	X	X	X	-	-	-	
BMP 220 (9-21')	pink	17.0	good strength, plastic	pink	0.5	medium strength, slightly sintered	pink	1.0	good strength, partially sintered	pink	3.0	good strength, partially sintered	brown	6.5	excellent strength, fully sintered	brick red	9.0	dense and tough, partially vitrified	trace yellow	X	X	X	X	-	-	-	1
BMP 220 (21-30')	brown	11.0	good strength, plastic	brown	0.5	medium strength, partially sintered	brown	1.0	good strength, partially sintered	brown	2.0	excellent strength, fully sintered	brown	4.5	dense and tough, partially vitrified	brown	5.5	dense and tough, fully vitrified	trace	X	X	-	X	-	-	-	
BMP 221 (6-24')	pink	9.5	medium strength, semi-plastic	pink	0.5	good strength, partially sintered	pink	4.5	excellent strength, partially sintered	pink	4.5	excellent strength, partially sintered	pale pink	6.0	excellent strength, fully sintered	pale pink	7.0	dense and tough, partially vitrified	trace	X	X	X	X	-	-	-	
NS 7/12 (5-26')	brown	16.0	good strength, plastic	pink	0.5	good strength, partially sintered	brown	2.0	good strength, partially sintered	pale brown	3.0	good strength, partially sintered	terra cotta	5.5	excellent strength, fully sintered	dark brown	6.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	
NS 7/12 (23-53')	olive	13.0	good strength, plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	4.0	good strength, partially sintered	terra cotta	4.5	good strength, fully sintered	dark terra cotta	8.0	excellent strength, partially vitrified	dark brown	1.0	dense and tough, fully vitrified, partly bloated	-	X	X	X	X	-	-	-	
NS 7/12 (50'6"-58'4")	grey	6.0	medium strength, semi-plastic	brown	1.0	good strength, partially sintered	brown	2.0	good strength, partially sintered	brown	3.0	excellent strength, fully sintered	dark brown	7.5	dense and tough, fully vitrified	dark brown	-	bloated and fused	-	X	-	-	X	-	-	X	2
NS 7/12 (58'4"-68'8")	grey	7.0	medium strength, semi-plastic	brown	0.5	good strength, partially sintered	brown	1.0	good strength, partially sintered	brown	2.0	excellent strength, fully sintered	dark brown	9.0	dense and tough, fully vitrified	dark brown	-	bloated and fused	-	X	-	-	X	-	-	X	2

* Logs of drillholes from which samples were taken are given in Table VIII.

1. The shrinkage on drying this clay is large.
2. Good bricks obtained when sample crushed so that 96% passed 10 B.S.S. Screen Aperture 0.666" and 75% passed 18 B.S.S. Screen Aperture 0.0336".

TABLE IX.....continued

7.

Samples from Deposit Cl 8 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
NS 7/12 (68'8"-75'7")	grey	6.0	medium strength, semi-plastic	brown	1.0	good strength, partially sintered	brown	2.0	good strength, partially sintered	brown	3.0	excellent strength, fully sintered	dark brown	8.0	dense and tough, fully vitrified	dark brown	—	bloated and fused	-	X...	-...	-...	X...	-...	-...	X...	2
NS 7/12 (75'7"-85'7")	grey	6.0	medium strength, semi-plastic	brown	1.0	good strength, partially sintered	brown	1.5	good strength, partially sintered	brown	2.0	excellent strength, fully sintered	dark brown	5.5	dense and tough, fully vitrified	dark brown	—	bloated and fused	-	X...	-...	-...	X...	-...	-...	X...	2

8.

Samples from Deposit Cl 9 - Rochedale

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 211 (0-15')	red-brown	14.0	fair strength, semi-plastic	terra cotta	0.1	fair strength, slightly sintered	terra cotta	0.5	fair strength, partially sintered	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	pink-terra cotta	5.5	excellent strength, fully sintered	yellow	X...	X...	X...	X...	-...	-...	-...	-
BMP 211 (15-24')	pink	10.0	weak, plastic	pink	1.0	good strength, partially sintered	pink	2.0	good strength, partially sintered	pink	6.5	excellent strength, partially sintered	grey	10.0	excellent strength, fully sintered	grey, trace brown efflor-escence	10.0	dense and tough, partially vitrified	-	X...	-...	-...	-...	-...	-...	-...	-
BMP 212 (0-24')	pink-grey	5.0	weak, non-plastic	pink	1.0	weak, partially sintered	pale pink	2.0	fair strength, partially sintered	pale pink	4.5	medium strength, fully sintered	grey	6.5	good strength, partially vitrified	grey	8.0	excellent strength, partially vitrified	-	X...	-...	-...	-...	-...	-...	-...	-
BMP 214 (0-18')	red-brown	12.0	medium strength, semi-plastic	pink	2.0	fair strength, partially sintered	pink	2.5	medium strength, partially sintered	pink	3.0	good strength, fully sintered	stone	4.5	good strength, partially vitrified	pale brown	4.5	excellent strength, partially vitrified	yellow	X...	X...	X...	X...	X...	-...	-...	-
BMP 214 (18-24')	white	13.0	good strength, plastic	white, trace of pink	1.0	good strength, partially sintered	white	3.0	excellent strength, partially sintered	white, trace grey	6.5	excellent strength, fully sintered	grey-white	7.0	dense and tough, partially vitrified	stone	9.0	dense and tough, fully vitrified	yellow	X...	X...	X...	X...	X...	-...	-...	-
BMP 215 (0-12')	brown	16.0	fair strength, semi-plastic	terra cotta	6.5	good strength, partially sintered	terra cotta	8.0	good strength, fully sintered	dark terra cotta	10.0	excellent strength, slightly vitrified	choco-late	11.0	dense and tough, partially vitrified	choco-late	12.0	dense and tough, fully vitrified	-	X...	-...	-...	-...	-...	-...	-...	-

* Logs of drillholes from which samples were taken are given in Table VIII.

2. Good bricks obtained when sample crushed so that 96% passed 10 B.S.S. Screen Aperture 0.666" and 75% passed 18 B.S.S. Screen Aperture 0.0336".

8.

TABLE IX.....continued

Samples from Deposit Cl 9 .....continued

*Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 215 (12-30')	grey	10.0	fair strength, semi-plastic	pale pink	1.0	weak, slightly sintered	pale pink	2.0	medium strength, partially sintered	pale pink	4.0	slight cracks, medium strength, partially sintered	pale grey	8.0	medium strength, cracked, fully sintered	pale yellow	9.0	medium strength, very cracked, partially vitrified	yellow	X	-	-	-	-	-	-	1
NS 6 (2-26')	pale brown	7.0	good strength, semi-plastic	pink	1.0	weak, slightly sintered	pale buff	2.0	medium strength, partially sintered	pale buff, brown efflor-escence	2.5	good strength, partially sintered	rose pink	3.0	excellent strength, fully sintered	brown	4.5	excellent strength, partially vitrified, few fused blebs	-	X	X	X	X	X	-	-	-
NS 6 (29-38')	pale khaki	8.0	good strength, semi-plastic	pale pink	1.0	fair strength, slightly sintered	pale buff	2.0	medium strength, partially sintered	pale brown	2.5	medium strength, partially sintered	rose pink	3.5	good strength, partially sintered	pale brown	4.5	excellent strength, vitrified, few fused blebs	-	X	X[2]	X[2]	X	-	-	-	-
NS 6 (41-45'6")	pale khaki	7.0	good strength, semi-plastic	pale pink	1.0	weak, slightly sintered	pale buff	2.5	medium strength, partially sintered	pale brown	3.0	medium strength, partially sintered	rose pink	3.5	medium strength, fully sintered	brown-pink	4.0	excellent strength, partially vitrified	dark brown	X	X[2]	X[2]	X	-	-	-	-

9.

Samples from Deposit Cl 11 - Upper Tingalpa

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 199 (0-6'; 12-15')	khaki	11.0	good strength, semi-plastic	terra cotta	0.7	good strength, partially sintered	pale terra cotta	3.0	good strength, partially sintered	pale terra cotta, trace brown efflor-escence	4.5	excellent strength, fully sintered	grey	6.5	dense and tough, partially vitrified	brown	7.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 199 (6-12')	grey	7.0	good strength, plastic	pink	0.5	fair strength, slightly sintered	pale pink	1.0	average strength, partially sintered	pale pink	1.5	good strength, partially sintered	grey	6.5	excellent strength, fully sintered	light brown	7.5	dense and tough, partially vitrified	trace	X	X	X	X	-	-	-	-
BMP 199 (15-24')	dark grey	7.0	average strength, plastic	pale pink	1.0	weak, trace sinter	pale pink	3.0	fair strength, trace sinter	pale pink	4.0	average strength, partially sintered	pale grey	8.5	good strength, fully sintered	light brown	11.0	dense and tough, partially vitrified	trace	X	X	X	X	-	-	-	-
BMP 200 (0-24')	choco-late	13.0	good strength, semi-plastic	pink	0.5	fair strength, slightly sintered	pink	1.0	medium strength, partially sintered	pale pink	4.0	excellent strength, partially sintered	brown, trace brown efflor-escence	8.5	excellent strength, fully sintered	pale khaki	9.0	dense and tough, partially vitrified	yellow	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
1. This clay contains a white mineral which on burning above 900°C expands and causes cracking.
2. Subject to check of porosity.

TABLE IX.....continued

9. Samples from Deposit Cl 11 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 200 (24-30')	grey-chocolate	8.0	fair strength, semi-plastic	pink	1.0	fair strength, slightly sintered	pale pink	2.0	medium strength, partially sintered	pale pink	3.0	good strength, partially sintered	pale pink	7.5	excellent strength, fully sintered	warm stone	9.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 201 (0-21'; 24-30')	grey, white efflorescence	12.0	good strength, semi-plastic	pale pink	2.0	medium strength, slightly sintered	pale pink	4.0	good strength, partially sintered	white, trace pink	6.5	excellent strength, fully sintered	stone	9.5	dense and tough, partially vitrified	stone	11.0	dense and tough, fully vitrified	yellow	X	X	-	X	X	-	-	-
BMP 899 (3-15')	brown	6.0	good strength, semi-plastic	terra cotta	0.2	weak, slightly sintered	terra cotta	0.5	weak, slightly sintered	terra cotta	1.0	medium strength, partially sintered	brown	2.0	medium strength, partially sintered	brick red	3.0	excellent strength, fully sintered	-	X	X	X	X	-	-	-	3
NS 9 (6-20')	pale brown	9.0	good strength, plastic	pink	2.0	fair strength, slightly sintered	pale pink	3.0	medium strength, partially sintered	cream	3.5	good strength, partially sintered	buff	4.5	excellent strength, fully sintered	buff	5.0	excellent strength, partially vitrified	-	X	X[4]	X[4]	X	X	X	-	-
NS 9 (21-55')	olive	12.0	good strength, semi-plastic	pink	0.5	weak, slightly sintered	pale buff	1.0	medium strength, partially sintered	light brown, brown efflorescence	1.5	good strength, partially sintered	rose pink, brown efflorescence	2.5	good strength, fully sintered	brown	5.5	excellent strength, partially vitrified	-	X	X	X	X	X	-	-	-

10. Samples from Deposit Cl 12 - Rochedale

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 196 (0-12')	pink	9.0	good strength, semi-plastic	pink	0.5	medium, strength, partially sintered	pink	3.0	good strength, partially sintered	pink, trace brown efflorescence	4.5	excellent strength, fully sintered	grey	9.0	dense and tough, partially vitrified	brown, black centre	5.0	dense and tough, slight bloating	trace	X	X	-	X	-	-	-	-
BMP 196 (12-27')	grey	5.0	fair strength, semi-plastic	pink	0.1	fair strength, partially sintered	pink	2.0	medium, strength, partially sintered	pale pink	4.0	excellent strength, fully sintered	light brown	9.0	dense and tough, partially vitrified	grey	12.0	dense and tough, fully vitrified	trace	X	X	-	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

3. This clay would be improved by blending with a plastic clay giving more strength at lower firing temperatures.

4. May be porous.

TABLE IX.....continued

10. Samples from Deposit C1 12 .....continued

Location *	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 197 (0-9')	pink-brown	11.0	good strength, semi-plastic	terra cotta	1.0	medium strength, partially sintered	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	3.0	excellent strength, fully sintered	pale khaki	9.0	dense and tough, partially vitrified	brown	11.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 197 (9-18')	pink-brown	7.0	good strength, semi-plastic	terra cotta	0.5	fair strength, partially sintered	pale terra cotta	1.5	good strength, partially sintered	pale terra cotta	2.5	good strength, fully sintered	stone	5.5	excellent strength, partially vitrified	brown	6.5	dense and tough, fully vitrified	yellow	X	X	X	X	-	-	-	1
BMP 204 (0-15')	warm brown	7.0	good strength, plastic	pink	1.0	fair strength	pink	3.0	good strength, partially sintered	pink	5.0	excellent strength, fully sintered	pink-brown	7.5	dense and tough, partially vitrified	pink-brown	8.5	dense and tough, fully vitrified	trace	X	X	-	X	-	-	-	-
BMP 204 (18-30')	grey	6.0	fair strength, semi-plastic	pink	1.0	fair strength, slightly sintered	pink	2.0	fair strength, slightly sintered	pale pink	4.0	medium strength, partially sintered	very pale pink	9.5	excellent strength, fully sintered	stone	11.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 205 (0-18')	brick red	12.0	medium strength, non-plastic	pink	0.5	medium strength, partially sintered	pink	1.0	good strength, partially sintered	pink	2.0	good strength, fully sintered	light brown	5.0	excellent strength, partially vitrified	light brown	6.5	dense and tough, partially vitrified	-	X	X	X	-	-	-	-	-
BMP 207 (0-18')	very pale brown	6.0	medium strength, semi-plastic	pink	1.0	fair strength, slightly sintered	pink	2.0	medium strength, partially sintered	pink	3.0	good strength, fully sintered	grey	8.5	excellent strength, partially vitrified	grey, trace brown efflor-escence	11.0	dense and tough, fully vitrified	-	X	X	-	X	-	-	-	-
BMP 208 (0-15')	brown	11.0	good strength, non-plastic	terra cotta	1.0	fair strength, slightly sintered	terra cotta	1.5	medium strength, partially sintered	terra cotta	2.3	good strength, fully sintered	terra cotta	4.0	excellent strength, partially vitrified	brown	5.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 208 (15-24')	pale pink	12.0	good strength, plastic	pale pink	0.1	good strength, partially sintered	pale pink	0.5	good strength, partially sintered	pale pink	1.0	excellent strength, partially sintered	pale pink	2.0	excellent strength, fully sintered	stone	7.5	dense and tough, partially vitrified	yellow	X	X	X	X	-	-	-	-
BMP 208 (24-30')	grey	8.0	medium strength, semi-plastic	pale pink	0.5	weak, slightly sintered	pale pink	1.0	weak, slightly sintered	pale pink	1.5	fair strength, partially sintered	pale stone	4.0	good strength, fully sintered	cream	5.0	good strength, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
1. Efflorescence unsightly.

TABLE IX.....continued

10.

Samples from Deposit Cl 12 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 209 (0-24')	pink-brown	11.0	medium strength, semi-plastic	pink	1.0	fair strength, partially sintered	pink	2.0	medium strength, partially sintered	pink	3.0	good strength, fully sintered	brown	7.5	excellent strength, partially vitrified	brown	8.5	dense and tough, fully vitrified	yellow	X	X	X	X	-	-	-	-
BMP 209 (24-30')	pale pink	11.0	medium strength, plastic	pale pink	1.0	good strength, partially sintered	pale pink	2.0	excellent strength, partially sintered	pale pink	4.0	excellent strength, fully sintered	stone	7.5	dense and tough, partially vitrified	stone	8.5	dense and tough, fully vitrified	large yellow	X	X	X	X	-	-	-	-
BMP 223 (15-30')	pink	7.0	medium strength, semi-plastic	pink	0.2	fair strength, slightly sintered	pink	0.5	good strength, partially sintered	pink	2.0	excellent strength, partially sintered	pale pink	4.0	excellent strength, fully sintered	pale pink	4.5	dense and tough, partially vitrified	trace	X	X	X	X	-	-	-	-
BMP 224 (6-12')	khaki	9.0	good strength, semi-plastic	terra cotta	1.0	medium strength, slightly sintered	terra cotta	1.5	good strength, partially sintered	terra cotta	4.0	excellent strength, fully sintered	brick red	8.0	dense and tough, partially vitrified	brick red	11.0	dense and tough, fully vitrified	-	X	X	-	X	-	-	-	-
BMP 224 (15-24')	grey	4.5	medium strength, plastic	brown	1.0	medium strength, slightly sintered	brown	1.5	good strength, partially sintered	terra cotta	2.5	excellent strength, partially vitrified	dark brown	9.0	dense and tough, partially vitrified	dark brown	4.5	dense and tough, fully vitrified	-	X	X	-	X	-	-	-	trace
BMP 225 (0-18')	pink	7.0	good strength, semi-plastic	pink	2.0	medium strength	pink	6.0	medium strength	pink	7.0	excellent strength	warm stone	8.5	excellent strength, fully sintered	brown	11.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 225 (18-30')	brown	10.0	good strength, plastic	pink	1.0	medium strength	pink	2.0	good strength	pink	4.5	excellent strength	brown	10.0	dense and tough, partially vitrified	dark brown	11.0	dense and tough, partially vitrified	-	X	X	-	X	-	-	-	-
BMP 226 (0-12')	cream	6.5	medium strength, semi-plastic	pale pink	1.0	medium strength	pale pink	2.0	good strength	pale pink	3.5	excellent strength	cream	6.5	excellent strength, fully sintered	cream	10.5	dense and tough, slightly vitrified	yellow	X	X	X	X	-	-	-	-
BMP 226 (12-24')	grey	9.5	good strength, plastic	pale pink	1.0	medium strength	pale pink	7.0	excellent strength	pale pink	8.5	excellent strength	stone	10.0	dense and tough, partially vitrified	stone	11.0	dense and tough, fully vitrified	yellow	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX..... continued

Samples from Deposit Cl 12 ..... continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 304 (0-30')	cream	7.0	good strength, plastic	pink	0.5	weak, slightly sintered	pink	1.0	medium strength, partially sintered	pink	2.0	medium strength, partially sintered	pale pink	5.5	good strength, partially sintered	brown	8.0	dense and tough, fully sintered	-	X	X	X	X	-	-	-	-
BMP 906 (3-18')	brown	13.0	good strength, plastic	terra cotta	2.0	medium strength, partially sintered	terra cotta	3.0	medium strength, partially sintered	terra cotta	5.5	medium strength, partially sintered	brown	6.5	good strength, fully sintered	brown	8.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 906 (18-30')	khaki	10.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	dark brown	5.5	excellent strength, fully sintered	dark brown	6.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 907 (3-30')	warm brown	8.0	good strength, plastic	pink	1.5	good strength, partially sintered	pink	2.0	good strength, partially sintered	pink	4.0	good strength, partially sintered	dark brown	9.0	excellent strength, fully sintered	brown	10.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
NS 14 (22'7"-28'1")	pink	7.5	weak, semi-plastic	white, trace pink	0.5	fair strength, slightly sintered	off-white	1.0	fair strength, slightly sintered	white	1.5	fair strength, slightly sintered	white	3.0	good strength, well sintered	pale cream	9.0	dense and tough, fully vitrified, few fused iron blebs	-	[1]X	[2]X	X	-	X	X	-	3
NS 14 (28'1"-43'4")	cream-brown	6.5	weak, semi-plastic	white, trace pink-brown efflorescence	0.2	weak, friable	off-white, brown efflorescence	0.5	weak, trace of sinter	white, brown efflorescence	1.0	weak, trace of sinter	off-white	2.5	medium strength, partially sintered	cream	6.5	dense and tough, partially vitrified	-	[1]X	-	X	-	X	X	-	3
NS 14 (43'4"-58'4")	grey	5.5	weak, semi-plastic	white, trace pink	0.5	weak, friable	off-white	1.0	weak, trace of sinter	off-white	1.5	weak, trace of sinter	off-white	6.5	medium strength, partially sintered	cream	11.0	dense and tough, fully vitrified	-	[1]X	-	X	-	X	X	-	4
NS 14 (58'4"-68'8")	grey	6.5	weak, semi-plastic	off-white	0.2	weak, friable	off-white	0.5	weak, trace of sinter	white	1.0	weak, trace of sinter	white	4.5	medium strength, slightly sintered	cream	8.0	dense and tough, partially vitrified	-	[1]X	-	X	-	X	X	-	4
NS 14 (68'8"-76'9")	grey	4.5	weak, semi-plastic	pale pink	0.5	weak, friable	pale pink	1.0	weak, friable	pink	2.0	weak, trace of sinter	pink	5.0	good strength, well sintered	brown	12.0	dense and tough, fully vitrified	-	[1]X	-	X	-	X	X	-	3

* Logs of drillholes from which samples were taken are given in Table VIII.
1. Temperature required to burn these bricks (1,200°C) could be uneconomical.
2. Colour unsuitable.
3. Partly fused and deformed at 1550°C.
4. Not tested at 1550°C.

TABLE IX..... continued

10.

Samples from Deposit Cl 12 ..... continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
NS 14 (77'9"-81'3")	grey	6.5	weak, semi-plastic	white, trace pink	0.3	weak, friable	off-white	0.5	fair strength, trace of sinter	white	1.0	fair strength, slightly sintered	white	4.5	good strength, partially sintered	off-white	9.5	dense and tough, partially vitrified	-	X[1]	-	X	-	X	X	-	5
NS 14 (108'10"-118' 7")	grey	8.0	weak, semi-plastic	pink-grey	1.0	medium strength, slightly sintered	pale pink	1.5	good strength, partially sintered	pale pink	2.0	good strength, slightly sintered	pink	4.0	excellent strength, fully sintered	brown	3.0	dense and tough, fully vitrified, fused blebs	-	X[1]	-	X	-	-	-	-	4

11.

Samples from Deposit Cl 13 - Mt. Gravatt-Belmont

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 329 (0-18')	buff	5.5	medium strength, non-plastic	pale pink	0.5	medium strength, partially sintered	pale pink	1.0	good strength, partially sintered	pale pink	1.5	good strength, partially sintered	very pale pink	5.5	excellent strength, fully sintered	buff	7.5	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 333 (6-30')	pale pink	7.0	good strength, semi-plastic	pale pink	1.0	good strength, partially sintered	pale pink	2.0	good strength, partially sintered	pale pink	3.0	good strength, partially sintered	very pale pink	6.5	excellent strength, fully sintered	buff	7.0	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 339 (3-30')	grey	6.5	good strength, non-plastic	pink	0.5	medium strength, partially sintered	pink	1.0	good strength, partially sintered	pink	2.5	excellent strength, fully sintered	brown	7.0	dense and tough, partially vitrified	brown	2.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 351 (9-30')	pale pink	8.0	good strength, plastic	pale pink	1.0	medium strength, partially sintered	pale pink	2.0	good strength, partially sintered	pale pink	3.0	good strength, partially sintered	pale grey	9.0	excellent strength, fully sintered	grey	10.0	dense and tough, partially vitrified	yellow	X	X	X	X	X	X	-	-
BMP 600 (6-18')	pink-brown	11.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	5.0	excellent strength, fully sintered	brown	6.0	dense and tough, partially vitrified	brown	7.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

1. Temperature required to burn these bricks (1,200°C) could be uneconomical.
4. Not tested at 1550°C.
5. Dense and tough, fully vitrified at 1550°C. Suitable for firebricks.

TABLE IX.....continued

11.

Samples from Deposit Cl 13 .....continued

*Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 600 (18-24')	white	16.0	good strength, plastic	pale pink	3.0	good strength, partially sintered	pale pink	6.5	good strength, partially sintered	pale pink	7.5	excellent strength, partially sintered	stone	6.5	dense and tough, partially vitrified	stone	3.0	dense and tough, fully vitrified	-	X	X	X	X	X	-	-	-
BMP 600 (24-30')	grey	9.0	good strength, semi-plastic	pale terra cotta	1.0	medium strength, partially sintered	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	3.0	excellent strength, fully sintered	warm stone	5.0	dense and tough, partially vitrified	brown	10.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 601 (6-18')	pink	7.0	good strength, non-plastic	pink	1.0	medium strength, partially sintered	pink	2.0	medium strength, partially sintered	pink	3.0	good strength, fully sintered	pink-brown	5.0	dense and tough, partially vitrified	brown	6.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 601 (18-30')	pink	10.0	good strength, semi-plastic	pale pink	0.2	medium strength, partially sintered	pale pink	6.5	good strength, partially sintered	pale pink	1.0	good strength, fully sintered	pink-brown	6.0	excellent strength, fully sintered	brown	7.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 602 (12-24')	pink	10.0	good strength, semi-plastic	pale pink	1.0	good strength, partially sintered	pale pink	2.0	good strength, partially sintered	pale pink	3.0	excellent strength, partially sintered	pale brown	6.0	dense and tough, partially vitrified	brown	8.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 888 (3-21')	warm brown	12.0	good strength, plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	excellent strength, partially sintered	terra cotta	3.0	excellent strength, fully sintered	brown	6.5	dense and tough, partially vitrified	brown	9.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 889 (9-24')	pink	8.0	good strength, semi-plastic	pink	2.0	weak strength, partially sintered	pink	3.0	medium strength, partially sintered	pink	4.0	medium strength, partially sintered	pink	8.0	good strength, partially sintered	pink	10.0	excellent strength, fully sintered	-	X	X	X	X	-	-	-	-

12.

Samples from Deposit Cl 14 - Gumdale

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 367 (0-24')	light grey	6.0	good strength, plastic	pink	7.5	good strength, partially sintered	pink	12.0	excellent strength, partially sintered	pink	12.5	excellent strength, fully sintered	buff	13.0	dense and tough, slightly vitrified	buff	14.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

12. Samples from Deposit Cl 14 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 368 (0-18')	off-white	5.0	good strength, plastic	off-white	0.2	medium strength, slightly sintered	off-white	1.0	medium strength, partially sintered	cream	4.0	good strength, partially sintered	grey-cream	4.5	good strength, fully sintered	pale brown	5.0	excellent strength, slightly vitrified	-	X	X	X	X	-	-	-	-
BMP 371 (0-18')	very pale brown	9.0	good strength, plastic	pale terra cotta	1.0	good strength, partially sintered	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	4.0	excellent strength, partially sintered	light brown	6.5	dense and tough, fully sintered	brown	7.5	dense and tough, slightly vitrified	-	X	X	X	X	-	-	-	-

Samples from Deposit Cl 15 - Ferny Grove

13. Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 860 (3-21')	light brown	7.0	good strength, semi-plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, fully sintered	terra cotta	3.0	good strength, fully sintered	brown	4.0	excellent strength, partially vitrified	dark brown	6.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 860 (21-27')	stone	6.0	good strength, semi-plastic	brown	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, fully sintered	brown	9.0	good strength, partially vitrified	dark brown	6.5	dense and tough, partly fused, trace bloating	-	X	X	X	X	-	-	-	-
BMP 861 (3-15')	light brown	5.0	medium strength, semi-plastic	brown	1.0	medium strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	terra cotta	8.0	good strength, fully sintered	dark brown	11.0	dense and tough, partly fused	-	X	X	X	X	-	-	-	-
BMP 864 (3-18')	light brown	7.5	good strength, semi-plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.5	good strength, partially sintered	terra cotta	3.5	excellent strength, partially vitrified	dark brick red	6.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

Samples from Deposit Cl 16 - Ferny Grove

14. Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 841 (9-24')	pale khaki	5.0	good strength, non-plastic	terra cotta	0.2	weak slightly sintered	terra cotta	0.5	weak slightly sintered	terra cotta	1.0	medium strength, partially sintered	dark terra cotta	1.5	medium strength, fully sintered	brown	2.0	good strength, fully vitrified	-	X	-	-	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

14.

Samples from Deposit Cl 16 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 871 (0-15')	grey-brown	8.0	good strength, semi-plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	4.0	excellent strength, fully sintered	terra cotta	5.5	excellent strength, partially vitrified	dark brick red	8.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 871 (9-15')	grey-brown	3.0	good strength, plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	3.0	excellent strength, fully sintered	brown	4.0	dense and tough, partially vitrified	brown	5.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 871 (15-39')	light brown	7.0	good strength, non-plastic	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	dark terra cotta	5.0	good strength, partially vitrified	dark brown	—	tough, partly fused; bloated 70%	-	X	X	X	X	-	-	X	-
BMP 874 (3-15')	light khaki	7.0	good strength, semi-plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	dark terra cotta	4.0	excellent strength, partially vitrified	dark brown	9.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 877 (3-12')	grey-brown	10.5	good strength, plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	brown	1.5	excellent strength, fully sintered	dark terra cotta	2.5	dense and tough, partially vitrified	dark brown	4.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 878 (3-18')	grey-brown	7.0	good strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	brown	5.0	excellent strength, fully sintered	dark brown	7.5	dense and tough, partially vitrified	dark brown	8.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

15.

Samples from Deposit Cl 17 - Aspley

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 25 (0-3') BMP 26 (0-6') BMP 27 (0-12')	brown	11.0	good strength, plastic	brick red, brown efflor-escence	0.5	good strength, partially sintered	brick red, brown efflor-escence	2.0	good strength, partially sintered	brick red, brown efflor-escence	3.0	excellent strength, partially sintered	brick red	6.0	dense and tough, partially vitrified	not tested			-	X	X	X	X	-	-	-	-
BMP 28 (0-15') BMP 29 (24-30')	grey-brown	8.0	good strength, plastic	brick red, slight brown efflor-escence	1.0	good strength, partially sintered	brick red, slight brown efflor-escence	3.0	good strength, partially sintered	brick red, brown efflor-escence	4.5	excellent strength, partially sintered	dark brown	10.0	dense and tough, fully vitrified	not tested			-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

15. Samples from Deposit Cl 17 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 24 (0-21') BMP 29 (6-18')	warm brown	10.0	good strength, plastic	pale pink, slight brown efflor-escence	0.5	good strength, partially sintered	pale pink, slight brown efflor-escence	2.0	good strength, partially sintered	very pale pink, brown efflor-escence	3.0	excellent strength, partially sintered	light buff	6.0	dense and tough, fully vitrified	not tested			yellow	X	X	X	X	-	-	-	-
BMP 24 (21-30') BMP 28 (15-18')	dark grey	7.5	good strength, non-plastic	white, pink tint, slight brown efflor-escence	3.0	good strength, partially sintered	pale pink, slight brown efflor-escence	4.5	good strength, partially sintered	very pale pink, brown efflor-escence	5.0	excellent strength, partially sintered	pale grey, pink tint	7.0	excellent strength, partially vitrified	not tested			-	X	X	X	X	-	-	-	-
BMP 32 (3-9') BMP 33 (3-15') BMP 35 (3-6')	khaki	10.5	good strength, plastic	brick red	0.5	good strength, partially sintered	brick red	2.5	good strength, partially sintered	brick red	3.3	excellent strength, fully sintered	brick red	5.0	excellent strength, fully sintered	not tested			-	X	X	X	X	-	-	-	-
BMP 33 (15-21') BMP 35 (12-15')	warm khaki	11.0	good strength, plastic	pale pink	1.0	good strength, partially sintered	pale pink	3.0	good strength, partially sintered	pale pink	4.0	excellent strength, fully sintered	grey	6.0	dense and tough, partially vitrified	not tested			yellow	X	X	X	X	-	-	-	-
BMP 36 (3-15') BMP 37 (3-6') BMP 38 (6-9')	warm brown	9.0	good strength, plastic	warm brown, trace brown efflor-escence	0.5	good strength, partially sintered	warm brown, trace brown efflor-escence	2.0	good strength, partially sintered	warm brown, trace brown efflor-escence	2.5	excellent strength, fully sintered	brick red	6.0	excellent strength, fully sintered	not tested			-	X	X	X	X	-	-	-	-

16. Samples from Deposit Cl 18 - Boondall

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 492 (6-24')	choco-late	17.0	good strength, plastic	brown	5.0	good strength, partially sintered	brown	9.0	cracked, partially sintered	brown, white efflor-escence	—	cracked	dark brown, white efflor-escence	—	cracked	dark brown, white efflor-escence	—	cracked	-	X	-	-	-	-	-	-	-
BMP 524 (6-21')	pink	12.0	good strength, semi-plastic	pale pink	0.5	good strength, partially sintered	pale pink	1.0	good strength, partially sintered	stone	2.0	excellent strength, fully sintered	stone	3.0	dense and tough, partially vitrified	warm stone	4.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

16. Samples from Deposit Cl 18 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 525 (9-21')	khaki	15.0	good strength, semi-plastic	brown, slight white efflor-escence	6.0	medium strength, partially sintered	brown, slight efflor-escence	7.5	medium strength, partially sintered	dark brick red, brown efflor-escence	8.9	medium strength, partially sintered	brick red, brown efflor-escence	15.0	good strength, fully sintered	brick red, brown efflor-escence	16.0	good strength, partially vitrified	-	X	-	-	-	-	-	-	-

17. Samples from Deposit Cl 19 - Sandgate-Brackenridge

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 479 (3-27')	light grey	5.0	good strength, plastic	pale pink	2.0	medium strength, fine cracks, partially sintered	pale pink	6.5	medium strength, cracked, partially sintered	pale pink	7.5	medium strength, cracked, partially vitrified	stone	17.0	medium strength, cracked, fully vitrified	stone	18.0	medium strength, cracked, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 480 (9-30')	choco-late	15.0	good strength, plastic	brown	0.5	good strength, partially sintered	brown	2.0	good strength, partially sintered	brown	6.0	excellent strength, fully sintered	brown	7.0	dense and tough, partially vitrified	brown, trace efflor-escence	7.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 482 (0-24')	choco-late	22.0	good strength, plastic	brown	3.0	medium strength, partially sintered	brown	5.5	good strength, partially sintered, slight cracking	brown	17.0	good strength, slight cracking, fully sintered	brown	14.0	good strength, slight cracking, partially vitrified	dark brown	16.7	good strength, slight cracking, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 483 (3-24')	brown	20.0	good strength, plastic	brown	6.0	good strength, partially sintered	brown	6.5	good strength, partially sintered	brown	8.5	excellent strength, fully sintered	dark brown	8.5	partially vitrified	dark brown	8.0	semi-fused	-	X	X	X	X	-	-	-	-

Samples from Deposit Cl 20 - Brighton

18. Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 476 (6-24')	brown	12.0	good strength, plastic	pink-buff	1.0	good strength, partially sintered	buff	2.0	excellent strength, partially sintered	cream	8.0	excellent strength, fully sintered	stone	10.0	dense and tough, partially vitrified	cream	11.5	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 527 (0-18')	off-white	9.0	medium strength, plastic	pale pink	0.5	medium strength, slightly sintered	pale pink	1.0	good strength, partially sintered	stone	2.0	excellent strength, partially sintered	stone	4.0	dense and tough, fully sintered	off-white	6.0	dense and tough, partially vitrified	-	X	-	-	-	X	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

19. Sample from Deposit Cl 21 - Bald Hills

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 450 (0-30')	light brown	12.0	good strength, plastic	brown	1.0	good strength, partially sintered	terra cotta	6.0	excellent strength, fully sintered	brown	7.0	dense and tough, partially vitrified	brown	9.0	dense and tough, fully vitrified	dark brown	—	partially fused	-	X	X	X	X	-	-	-	-

20. Samples from Deposit Cl 22 - Bald Hills

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 421 (9-30')	pink	13.0	good strength, semi-plastic	pale terra cotta	1.0	good strength, partially sintered	brown	4.0	good strength, partially sintered	brown	5.0	good strength, partially sintered	brick red	6.0	dense and tough, partially vitrified	brick red	7.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 422 (0-21')	dark brown	19.0	good strength, plastic	brown	1.0	cracked, partially sintered	brown	2.0	cracked, partially sintered	brown	3.0	cracked	dark brown	3.0	cracked	brick red	5.5	cracked	-	-	-	-	-	-	-	-	-
BMP 423 (12-30')	grey	18.0	good strength, plastic	brown	3.0	good strength, cracked surface	pale terra cotta	—	cracked surface	terra cotta	—	cracked surface	brown	—	cracked surface	dark brown	11.0	fully vitrified	-	-	-	-	-	-	-	-	-
BMP 424 (0-9')	brown	17.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	slightly cracked, partially sintered	brown	4.0	slightly cracked, partially sintered	brown	5.0	slightly cracked, fully sintered	dark brown	1.0	slightly cracked, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 457 (12-30')	light brown	16.0	good strength, plastic	buff	1.0	good strength, partially sintered	buff	2.0	good strength, partially sintered	buff	3.0	excellent strength, fully sintered	buff	4.0	dense and tough, partially vitrified	pale brown	5.5	dense and tough, fully vitrified	-	X	X	X	X	X	-	-	-
BMP 458 (0-27')	brown	22.0	cracked, plastic	terra cotta	—	cracked, partially sintered	terra cotta	—	cracked, partially sintered	brown	—	cracked, fully sintered	dark brown	—	partially vitrified	dark brown	—	semi-fused	-	-	-	-	-	-	-	-	-
BMP 459 (0-27')	stone	17.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	3.0	excellent strength, fully sintered	brown	4.0	dense and tough, partially vitrified	brick red	4.0	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 464 (9-21')	brown	17.0	good strength, plastic	terra cotta	2.0	slightly cracked, partially sintered	terra cotta	4.0	good strength, slightly cracked, partially sintered	brown	8.0	good strength, slightly cracked, fully sintered	dark brown	9.0	good strength, slightly cracked, partially vitrified	dark brown	—	excellent strength, fully vitrified	-	X	-	-	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

20. Samples from Deposit Cl 22 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 489 (0-15')	choco-late	15.0	good strength, plastic	brown	3.5	good strength, slightly cracked, partially sintered	brown	4.0	good strength, slight cracking, partially sintered	brown	5.0	cracked, partially sintered	brown	10.0	cracked, fully sintered	brick red	4.0	cracked, partially vitrified	-	X	-	-	-	-	-	-	-

21. Samples from Deposit Cl 23 - Bald Hills

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 387 (9-30')	brown	9.0	good strength, semi-plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	terra cotta	7.5	excellent strength, fully sintered	dark brick red	12.0	dense and tough, partially vitrified	dark brick red	11.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 388 (6-30')	pale grey	12.0	good strength, plastic	pink	1.0	good strength, partially sintered	pink	5.0	good strength, partially sintered	khaki	8.5	excellent strength, fully sintered	brown	10.0	dense and tough, partially vitrified	brown	11.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 392 (0-18')	buff	12.0	good strength, plastic	brown	1.0	good strength, cracked, partially sintered	brown	2.0	good strength, cracked, partially sintered	brown	3.0	good strength, cracked, partially sintered	dark brown	6.5	excellent strength, cracked, fully sintered	dark brown	10.0	dense and tough, cracked, fully vitrified	-	[1]X	-	-	-	-	-	-	-
BMP 392 (18-30')	yellow	15.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	4.0	good strength, fully sintered	dark brown	5.0	excellent strength, partially vitrified	dark brown	4.0	dense and tough, fully vitrified, slight swelling	-	X	-	-	-	-	-	-	-
BMP 394 (0-18')	pale pink	10.0	good strength, semi-plastic	brown	2.0	good strength, partially sintered	brown	3.0	good strength, partially sintered	brown	5.5	good strength, fully sintered	dark brown	8.0	excellent strength, partially vitrified	dark brown	15.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 395 (0-18')	brown	8.0	good strength, non-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	light terra cotta	3.0	excellent strength, fully sintered	brown	5.0	excellent strength, partially vitrified	brown	6.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 396 (0-30')	pale pink-brown	5.5	good strength, plastic	brown	0.5	good strength, partially sintered	brown	1.0	good strength, partially sintered	brown	1.5	good strength, partially sintered	brick red	2.5	excellent strength, fully sintered	brick red	3.5	dense and tough, partially vitrified	-	X	-	-	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
1. Care would have to be taken in the drying of this clay to minimise cracking.

TABLE IX.....continued

21. Samples from Deposit Cl 23 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 398 (9-24')	pale pink-brown	8.0	good strength, plastic	brown	1.0	good strength, partially sintered	brown	2.0	good strength, partially sintered	brown	3.0	good strength, partially sintered	grey	7.5	excellent strength, fully sintered	grey, brown efflor-escence	5.0	dense and tough, cracked, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 405 (3-24')	pale pink	9.0	good strength, plastic	pale pink	1.0	good strength, partially sintered	pale pink	2.0	good strength, partially sintered	pale pink	3.0	excellent strength, partially sintered	cream	6.0	excellent strength, fully sintered	yellow	7.5	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 407 (0-12')	stone	16.0	medium strength, plastic	buff	1.0	good strength, partially sintered	buff	2.0	excellent strength, partially sintered	cream	5.0	excellent strength, partially sintered	deep cream	6.0	dense and tough, fully sintered	light brown	7.5	dense and tough, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 407 (12-27')	khaki	18.0	good strength, plastic	cracks on drying and becomes worse on firing															-	-	-	-	-	-	-	trace	-
BMP 408 (0-30')	light brown	11.0	good strength, semi-plastic	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	5.0	excellent strength, partially sintered	brown, dark brown efflor-escence	7.0	excellent strength, fully sintered	brick red	10.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 412 (0-30')	light pink	12.0	good strength, plastic	very pale pink	1.0	good strength, partially sintered	very pale pink	2.0	good strength, partially sintered	cream	3.0	excellent strength, partially sintered	cream	5.0	dense and tough, partially vitrified	cream	9.0	dense and tough, fully vitrified	-	X	X	X	X	X	-	-	-
BMP 413 (0-6'; 12-24')	off-white	8.0	good strength, semi-plastic	cream	0.5	fair strength, partially sintered	pale pink	1.5	medium strength, partially sintered	cream	2.0	good strength, partially sintered	cream	3.0	good strength, partially sintered	cream	4.0	good strength, fully sintered	-	X	X	X	X	X	-	-	-
BMP 431 (0-36')	brown	16.0	good strength, plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	4.0	good strength, fully sintered	brown	6.5	good strength, partially vitrified	dark brown	4.0	dense and tough, fully vitrified	black	—	fused and bloated	-	X	-	-	-	-	-	fair	-
NS 10 (5-54')	brown	17.0	good strength, cracks under pressure, plastic	brown	0.5	good strength, partially sintered	pale brown	1.0	good strength, partially sintered	pale brown	1.0	good strength, few cracks, partially sintered	dark terra cotta	4.5	good strength, fully sintered	dark terra cotta	—	good strength, cracked, partially vitrified	-	X[2]	X	X[2]	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

2. May distort on drying.

TABLE IX.....continued

21. Samples from Deposit Cl 23 .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
NS 10 (54-63')	light olive	12.0	good strength, plastic	brown	1.0	fair strength, slightly sintered	pale brown	2.0	good strength, partially sintered	buff	3.0	good strength, partially sintered	terra cotta	4.5	excellent strength, partially vitrified	terra cotta	5.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
NS 10 (65-68')	olive	16.0	good strength, cracks, plastic	brown	1.0	cracked, partially sintered	grey	5.0	cracked, partially sintered	grey	6.0	cracked, partially sintered	terra cotta	11.5	cracked, fully sintered	brown, brown efflor-escence	7.0	cracked, fully vitrified	-	-	-	-	-	-	-	-	-

22. Sample from Deposit Cy 1 - Lytton

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 575 (0-15')	grey	17.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	1.5	fully sintered, slight bloating	terra cotta	3.0	partially vitrified slight bloating	dark brown	—	dense and tough, fully vitrified, bloated	—	—	—	-	X	-	-	-	-	-	X	- (250%)

23. Samples from Deposit Cy 2 - Bulwer Island

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 548 (0-12')	grey	19.0	good strength, plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	3.0	cracked, fully sintered, slightly bloated	terra cotta	1.0	partially vitrified, cracked, bloated	dark brown	—	semi-fused, bloated 100%	—	—	—	-	X	-	-	-	-	-	X	- (200%)
BMP 565 (0-9')	grey, slight white efflor-escence	17.0	good strength, plastic	terra cotta	2.0	good strength, cracked, partially sintered	terra cotta	5.0	cracked, slightly bloated	brown	—	cracked, partially vitrified, semi-bloated	dark brown	—	fully vitrified, bloated	—	—	—	-	-	-	-	-	-	-	X	- (300%)

24. Sample from Deposit Cy 3 - Bald Hills

Analyst: C.H. Couper, Government Chemical Laboratory, Brisbane

BMP 446 (0-24')	grey, white efflor-escence	9.0	good strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	6.0	good strength, partially sintered	brown, efflor-escence	7.0	excellent strength, fully sintered	dark brown	6.0	dense and tough, partially vitrified	dark brown	—	fully vitrified, bloated 43%	-	X	-	-	-	-	-	X	1

* Logs of drillholes from which samples were taken are given in Table VIII.

1. This is a very good bloating clay.

TABLE IX.....continued

25. Samples from Minor Clay Occurrences

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 189 (0-18')	pink-brown	5.0	fair strength, plastic	pink	0.1	weak, trace sinter	pink	1.0	fair strength, slightly sintered	pale pink	4.0	good strength, fully sintered	pale pink	5.0	excellent strength, partially vitrified	pale pink, trace brown efflor-escence	6.5	dense and tough, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 189 (18-24')	brown	8.0	fair strength, plastic	pink	0.5	fair strength, partially sintered	pink	2.0	good strength, partially sintered	pink, trace brown efflor-escence	4.5	excellent strength, fully sintered	pink-brown, trace brown efflor-escence	9.0	dense and tough, partially vitrified	grey-brown	10.0	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 190 (0-6')	warm grey	8.0	good strength, semi-plastic	pale terra cotta	1.0	fair strength, partially sintered	pale terra cotta	1.0	medium strength, partially sintered	buff	2.0	good strength, partially sintered	pale khaki	6.5	excellent strength, partially vitrified	faded khaki	9.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 190 (6-12')	grey	5.0	fair strength, semi-plastic	white, trace pink	1.5	weak, trace sinter	white, trace pink	2.0	fair strength, slightly sintered	white	3.0	medium strength, partially sintered	white, trace yellow	9.0	dense and tough, fully sintered	white	11.0	dense and tough, partially vitrified	-	X	X	X	X	X	X	-	-
BMP 190 (12-15')	pale grey	6.0	good strength, semi-plastic	white, trace grey	0.1	weak, trace sinter	white	0.2	medium strength, partially sintered	white	2.0	good strength, fully sintered	white, trace yellow	7.5	dense and tough, partially vitrified	white, trace grey	9.0	dense and tough, fully vitrified	-	X	X	X	X	X	X	-	-
BMP 193 (9-18')	pale pink	10.0	good strength, plastic	pale pink	0.5	fair strength, partially sintered	pale pink	2.0	excellent strength, fully sintered	very pale pink	4.0	excellent strength, partially vitrified	stone	7.5	dense and tough, fully vitrified	pale grey	8.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 194 (0-12')	stone	4.0	fair strength, semi-plastic	pink	0.1	weak, slightly sintered	pink	1.0	medium strength, partially sintered	pale pink	2.0	good strength, fully sintered	pale pink, brown efflor-escence	3.0	excellent strength, partially vitrified	grey	7.5	dense and tough, fully vitrified	-	X	X	-	-	-	-	-	-
BMP 194 (12-24')	pale pink	5.0	good strength, semi-plastic	pink	0.1	weak, friable, not sintered	pink	1.5	fair strength, slightly sintered	pink	2.5	medium strength, partially sintered	pink-brown	4.5	good strength, fully sintered	grey	7.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 195 (0-9')	light grey	4.0	good strength, plastic	pale terra cotta	0.1	weak, friable, not sintered	pale terra cotta	0.5	fair strength, slightly sintered	stone	1.0	medium strength, partially sintered	faded khaki	1.5	good strength, partially sintered	faded khaki	4.0	dense and tough, partially vitrified	slight	X	-	-	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

Samples from Minor Clay Occurrences .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 198 (0-9')	pale grey	4.0	fair strength, non-plastic	pale pink	0.1	weak, friable, trace sinter	pale pink	1.0	weak, partially sintered	pale pink	2.0	fair strength, partially sintered	light brown	4.0	good strength, fully sintered	grey	5.5	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 202 (0-15')	pink-grey	11.0	good strength, plastic	pale pink	2.0	fair strength, slightly sintered	pale pink	3.0	good strength, partially sintered	white, trace pink	4.0	excellent strength, fully sintered	pale cream	6.0	dense and tough, partially vitrified	pale stone	7.5	dense and tough, partially vitrified	yellow	X	X	-	X	X	-	-	-
BMP 202 (15-30')	grey	8.5	fair strength, semi-plastic	pale pink	0.5	fair strength, slightly sintered	very pale pink	1.0	medium strength, partially sintered	very pale pink	2.5	good strength, partially sintered	pale pink	8.0	excellent strength, fully sintered	stone	10.0	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 203 (0-12')	warm brown	8.5	fair strength, semi-plastic	pink	0.5	fair strength, slightly sintered	pink	1.0	medium strength, partially sintered	pale pink	1.5	medium strength, partially sintered	pink, trace brown efflorescence	8.0	good strength, fully sintered	pale brown	9.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	...	-
BMP 210 (0-12')	pink, brown efflorescence	13.0	good strength, plastic	pale pink	0.5	good strength, partially sintered	pale pink	1.0	excellent strength, partially sintered	pale pink	2.0	excellent strength, fully sintered	stone	5.0	dense and tough, partially vitrified	stone	6.5	dense and tough, fully vitrified	yellow	X	X	X	X	-	-	-	-
BMP 210 (12-18')	grey	12.0	good strength, semi-plastic	pink, brown efflorescence	1.0	good strength, partially sintered	pink, brown efflorescence	2.0	excellent strength, partially sintered	pink, dark brown efflorescence	4.5	excellent strength, fully sintered	grey, brown efflorescence	5.5	dense and tough, partially vitrified	grey, brown efflorescence	2.0	dense and tough, fully vitrified	trace yellow	-	-	-	-	-	-	-	-
BMP 210 (18-30')	grey	8.0	good strength, semi-plastic	pink	1.0	good strength, partially sintered	pink	2.0	excellent strength, partially sintered	pink	4.5	excellent strength, fully sintered	grey	8.0	dense and tough, partially vitrified	buff, brown efflorescence	4.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 216 (0-24')	pale pink	10.0	fair strength, semi-plastic	pink	0.1	fair strength, slightly sintered	pink	1.0	fair strength, slightly sintered	pink	2.0	medium strength, partially sintered	brown	8.0	good strength, fully sintered	grey, brown efflorescence	7.0	dense and tough, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 217 (0-9')	grey	6.0	fair strength, semi-plastic	pink	0.5	fair strength, slightly sintered	pink	1.0	medium strength, slightly sintered	pink	2.0	good strength, partially sintered	pink	6.5	excellent strength, partially sintered	pale brown	6.5	excellent strength, fully sintered	-	X	X	X	X	-	-	-	-
BMP 217 (9-30')	dark grey	5.0	weak, plastic	pale pink	0.5	weak, friable	pale pink	1.0	weak, friable	very pale pink	2.0	weak, friable	white, trace grey	3.0	fair strength, slightly sintered	cream	5.5	medium strength, partially sintered	trace yellow	-	-	-	-	-	-	-	1

* Logs of drillholes from which samples were taken are given in Table VIII.

1. May be of use if blended with other clays.

TABLE IX.....continued

25.

Samples from Minor Clay Occurrences .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 218 (0-9')	light pink	9.0	good strength, plastic	pink	0.1	fair strength, slightly sintered	pink	0.5	medium strength, slightly sintered	pink	1.0	good strength, partially sintered	pink-brown	6.5	excellent strength, fully sintered	brown	7.0	dense and tough, partially vitrified	yellow	X	X	X	X	-	-	-	-
BMP 218 (9-24')	grey	6.0	good strength, plastic	pink	0.2	fair strength, slightly sintered	pink	0.5	fair strength, slightly sintered	pink	1.0	medium strength, partially sintered	pink-brown	6.5	excellent strength, fully sintered	brown	7.5	dense and tough, partially vitrified	yellow	X	X	X	X	-	-	-	-
BMP 228 (0-12')	cream	9.0	medium strength, semi-plastic	white, trace pink	1.0	medium strength	white	1.5	good strength	white, trace cream	2.0	excellent strength	cream	3.5	excellent strength, fully sintered	cream	4.5	dense and tough, slightly vitrified	yellow	X	X	X	X	X	-	-	-
BMP 228 (12-24')	grey	13.0	good strength, plastic	cream	2.0	good strength, partially sintered	cream	3.0	good strength, partially sintered	pale pink	4.0	excellent strength, partially sintered	cream	8.0	dense and tough, fully sintered	stone	10.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 254 (0-12')	brown	12.0	good strength, plastic	terra cotta	3.0	fair strength, partially sintered	terra cotta	4.0	good strength, partially sintered	terra cotta	8.5	good strength, partially sintered	brown	9.5	dense and tough, fully sintered	brick red	6.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 259 (0-12')	dark brown	15.0	good strength, plastic	terra cotta	0.2	fair strength, slightly sintered	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	3.0	good strength, fully sintered	brick red	2.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 259 (12-24')	dark brown	13.0	good strength, plastic	brown	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	6.5	good strength, fully sintered	dark brown	5.5	dense and tough, partially vitrified	-	X	X	X	X	X	X	-	-
BMP 259 (24-30')	khaki	13.0	good strength, plastic	brown	0.5	fair strength, partially sintered	terra cotta	1.0	medium strength, partially sintered	dark brown	9.0	dense and tough, partially vitrified	black	—	fused	black	—	fully fused	-	X	-	-	-	-	-	X	-
BMP 262 (0-12')	brown	14.0	good strength, semi-plastic	brown	2.0	fair strength, partially sintered	terra cotta	3.0	medium strength, partially sintered	terra cotta	7.0	good strength, partially sintered	brown	15.0	excellent strength, fully sintered	brick red	12.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX.....continued

Samples from Minor Clay Occurrences .....continued

Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 283 (9-18')	pale pink	12.0	good strength, plastic	pale pink	0.5	good strength, partially sintered	pale pink	1.0	good strength, partially sintered	pale pink	2.0	good strength, partially sintered	pink-grey	5.5	excellent strength, fully sintered	stone	6.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 283 (18-30')	pale grey	8.0	good strength, plastic	pale pink	2.0	good strength, partially sintered	pale pink	4.0	good strength, partially sintered	very pale pink	5.0	excellent strength, partially sintered	very pale pink	7.5	excellent strength, fully sintered	stone	9.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 292 (0-12')	brown	15.0	good strength, semi-plastic	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	good strength, partially sintered	terra cotta	5.0	good strength, partially sintered	brown	6.0	excellent strength, fully sintered	brick red	8.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 294 (0-9')	khaki	14.0	good strength, semi-plastic	terra cotta	5.0	medium strength, partially sintered	terra cotta	7.0	good strength, fully sintered	brown	11.0	excellent strength, partially vitrified	grey	14.0	dense and tough, partially vitrified	brown	13.0	dense and tough, fully vitrified	yellow	X	-	-	-	-	-	-	-
BMP 294 (9-18')	dark brown	13.0	good strength, semi-plastic	terra cotta	7.5	medium strength, cracked, partially sintered	terra cotta	10.0	medium strength, cracked, partially sintered	brown	14.0	good strength, cracked, fully sintered	dark grey-brown	16.0	good strength, cracked, partially vitrified	choco-late	12.0	good strength, cracked, fully vitrified	-	-	-	-	-	-	-	-	-
BMP 294 (18-33')	brown	20.0	good strength, badly cracked, non-plastic	brown	0.1	good strength, partially sintered	brown	1.0	medium strength, partially sintered	brown	2.0	good strength, fully sintered	brown	3.0	good strength, partially vitrified	black	—	good strength, fully vitrified	-	-	-	-	-	-	-	-	1
BMP 298 (0-9')	brown	18.0	good strength, badly cracked, non-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	4.0	good strength, partially sintered	brown	5.0	good strength, partially vitrified	brown-red	2.0	excellent strength, fully vitrified	-	-	-	-	-	-	-	-	1
BMP 309 (6-18')	pale pink	15.0	good strength, plastic	pink	0.5	good strength, partially sintered	pale pink	1.0	good strength, partially sintered	pale brown	1.5	excellent strength, partially sintered	pale brown	2.5	excellent strength, fully sintered	pale brown	3.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 310 (3-12')	buff	12.0	good strength, plastic	pale terra cotta	0.5	good strength, partially sintered	pale terra cotta	1.0	good strength, partially sintered	pale terra cotta	1.5	good strength, partially sintered	brown	2.0	good strength, partially sintered	terra cotta	3.0	excellent strength, fully sintered	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

1. Possibly could be used for bricks, tiles, pipes and common pottery if blended with suitable siliceous clays, grog or sand.

TABLE IX.....continued

25. Samples from Minor Clay Occurrences ...continued

Location *	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Fired at 900°C: Shrinkage from air dried %	Fired at 900°C: Comment	Fired at 1,000°C: Colour	Fired at 1,000°C: Shrinkage from air dried %	Fired at 1,000°C: Comment	Fired at 1,100°C: Colour	Fired at 1,100°C: Shrinkage from air dried %	Fired at 1,100°C: Comment	Fired at 1,200°C: Colour	Fired at 1,200°C: Shrinkage from air dried %	Fired at 1,200°C: Comment	Fired at 1,300°C: Colour	Fired at 1,300°C: Shrinkage from air dried %	Fired at 1,300°C: Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 310 (12-24')	grey	15.0	good strength, plastic	pink	0.5	good strength, partially sintered	pink	1.0	good strength, partially sintered	pale brown	1.5	good strength, partially sintered	pale brown	2.0	excellent strength, fully sintered	brown, few fused blebs	3.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 312 (9-15')	grey	12.0	good strength, plastic	brown	2.0	good strength, partially sintered	brown	4.0	good strength, partially sintered	brown	6.5	good strength, partially sintered	brown	8.0	excellent strength, fully sintered	brick red	7.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 312 (15-21')	pale grey	13.0	medium strength, semi-plastic	pink	2.0	good strength, partially sintered	pink	4.0	good strength, partially sintered	pale brown	5.5	excellent strength, fully sintered	pale brown	8.0	dense and tough, partially vitrified	brown	13.0	dense and tough, fully vitrified	-	X	X	-	X	-	-	-	2
BMP 313 (6-18')	cream	9.0	good strength, semi-plastic	brown	1.0	good strength, partially sintered	brown	3.0	good strength, partially sintered	dark brown	10.0	good strength, fully sintered	brick red	11.0	excellent strength, fully sintered	dark terra cotta	13.0	excellent strength, slightly vitrified	-	X	X	X	X	-	-	-	-
BMP 321 (9-27')	pale pink	5.0	medium strength, non-plastic	pale terra cotta	1.0	good strength, partially sintered	pale terra cotta	2.0	good strength, partially sintered	pale terra cotta	4.0	good strength, partially sintered	brown	13.0	good strength, fully sintered	terra cotta	14.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 328 (3-21')	buff	8.0	medium strength, semi-plastic	pale pink	1.0	medium strength, partially sintered	pale pink	1.5	good strength, partially sintered	pale pink	2.0	good strength, partially sintered	very pale pink	5.0	excellent strength, fully sintered	very pale pink	8.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 343 (9-24')	pale pink	10.0	good strength, plastic	pale pink	1.0	good strength, partially sintered	very pale pink	2.0	good strength, partially sintered	very pale pink	3.0	good strength, partially sintered	stone	10.0	dense and tough, slightly vitrified	pale grey	12.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 345 (0-24')	near white	2.0	weak, friable, non-plastic	light buff	0.5	weak, friable	buff	1.0	medium strength, partially sintered	buff	2.0	good strength, partially sintered	yellow-grey	7.5	dense and tough, partially vitrified	brown	0.5	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	3
BMP 348 (0-15')	red	7.0	good strength, non-plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	3.0	excellent strength, fully sintered	brick red	4.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.
2. This clay would give better results if blended with silica grog or a suitable clay to reduce shrinkage.
3. This clay should prove suitable for tiles, pipes and common pottery if blended with other clays.

TABLE IX.....continued

Samples from Minor Clay Occurrences .....continued

Location *	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 352 (3-30')	grey	6.0	medium strength, plastic	white	0.2	weak, friable	white	0.5	medium strength, slightly sintered	white	1.0	medium strength, partially sintered	white	7.0	good strength, partially sintered	pale cream	11.0	excellent strength, fully sintered, slightly vitrified	-	X	X	X	X	X	X	-	-
BMP 353 (0-15')	buff	5.0	medium strength, plastic	light terra cotta	0.2	good strength, partially sintered	light terra cotta	0.4	good strength, partially sintered	light terra cotta	0.6	good strength, partially sintered	brown	1.5	good strength, fully sintered	brown	2.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 354 (0-6')	pale grey	16.0	good strength, plastic	brown	2.0	weak, slightly sintered	light brown	4.0	good strength, partially sintered	light brown	8.0	excellent strength, fully sintered	khaki	14.0	dense and tough, partially vitrified	brown	20.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	1
BMP 358 (12-30')	grey	8.0	good strength, plastic	pale pink	0.5	weak, slightly sintered	pale pink	1.5	medium strength, partially sintered	pale pink	3.0	good strength, partially sintered	stone	6.5	good strength, fully sintered	stone	7.0	dense and tough, partially vitrified	-	X	X	X	X	X	X	-	-
BMP 377 (0-24')	brown	17.0	good strength, plastic	brown	3.0	good strength, partially sintered	brown	6.5	good strength, partially sintered	brown	8.0	good strength, fully sintered	choco-late	12.0	dense and tough, partially vitrified	dark choco-late	6.5	dense and tough, fully vitrified, slight bloating	-	X	-	-	-	-	-	-	-
BMP 416 (0-12')	off-white	10.0	good strength, plastic	pale pink	0.5	medium strength, partially sintered	off-white	1.0	good strength, partially sintered	off-white	1.0	good strength, cracked, partially sintered	pale brown	—	cracked, fully sintered	brown	—	cracked, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 425 (0-33')	light brown	16.0	good strength, plastic	terra cotta	4.0	cracked, partially sintered	terra cotta	6.0	cracked, partially sintered	brown, white efflor-escence	—	cracked, fully sintered	dark brown	—	cracked, partially vitrified	very dark brown	—	fused, bloated 50%	-	-	-	-	-	-	-	fair	-
BMP 453 (0-15')	brown	5.0	good strength, plastic	terra cotta	0.2	good strength, partially sintered	terra cotta	0.5	good strength, partially sintered	dark brown	2.0	excellent strength, partially sintered	dark brown	—	dense and tough, partly fused	black	—	about 75% fused, bloated[2]	-	X	X	-	X	-	-	X	-
BMP 511 (0-30')	dark brown	17.0	good strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	dark brown	5.0	excellent strength, fully sintered	dark brown	6.0	dense and tough, partially vitrified	brick red	6.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

1. The large shrinkage on firing may be reduced by blending with sand, grog or siliceous low shrinkage clay.
2. Fired at 1250°C.

TABLE IX..... continued

25. Samples from Minor Clay Occurrences.....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 517 (0-21')	khaki	15.0	good strength, plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	excellent strength, fully sintered	dark brown	2.5	dense and tough, partially vitrified	brick red	3.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 517 (21-27')	light khaki	17.0	good strength, plastic	pale terra cotta	1.0	good strength, partially sintered	pale buff	2.0	good strength, partially sintered	yellow	7.0	glazed, fully vitrified	yellow	—	fused, slight bloating	yellow-brown	—	fully fused, slight bloating	-	X	-	-	-	-	-	semi	-
BMP 522 (0-18')	khaki	18.0	good strength, semi-plastic	terra cotta, white efflor-escence	4.0	good strength, partially sintered	terra cotta, white efflor-escence	6.5	good strength, partially sintered	dark brown	—	fully vitrified	dark brown	—	fused, slight bloating	dark brown	—	fused and flowed, slight bloating	-	X	-	-	-	-	-	-	-
BMP 522 (18-27')	green khaki	12.0	good strength, semi-plastic	pale terra cotta	5.0	cracked, partially sintered	pale terra cotta	10.0	cracked, partially sintered	dark brown	11.0	fully vitrified	dark brown	—	fused, bloated	dark brown	—	fused, bloated	-	-	-	-	-	-	X	-	-
BMP 555 (0-15')	pale grey	6.0	medium strength, non-plastic	terra cotta	0.2	weak, slightly sintered	terra cotta	0.5	weak, slightly sintered	terra cotta	1.0	weak, fully sintered	dark brown	5.0	medium strength, partially vitrified	dark brown	11.0	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	3
BMP 567 (0-9')	pale grey	10.0	good strength, plastic	terra cotta	0.5	weak, partially sintered	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	medium strength, fully sintered	dark brown	5.0	dense and tough, partially vitrified	dark brown	0.2	dense and tough, fully vitrified	-	X	-	-	-	-	-	-	-
BMP 584 (9-30')	brown-pink	10.0	good strength, plastic	terra cotta	5.0	good strength, partially sintered	terra cotta	8.5	excellent strength, partially sintered	terra cotta	10.0	dense and tough, fully sintered	dark terra cotta	13.0	dense and tough, partially vitrified	dark brown	10.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 587 (0-15')	pale pink	17.0	good strength, plastic	pale pink	3.0	good strength, partially sintered	pale pink	3.5	good strength, partially sintered	pale pink	4.5	excellent strength, fully sintered	stone	6.5	dense and tough, partially vitrified	stone	8.5	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 587 (15-30')	pale pink	16.0	good strength, plastic	pink	1.0	medium strength, partially sintered	pink	3.0	good strength, partially sintered	pink	4.0	excellent strength, fully sintered	dark stone	5.0	dense and tough, partially vitrified	pale brown	6.5	dense and tough, fully vitrified	-	X	X	X	X	X	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

3. This clay would probably be suitable for blending with other clays to reduce their shrinkage.

TABLE IX..... continued

Samples from Minor Clay Occurrences .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 592 (6-18')	pale pink	12.0	medium strength, non-plastic	white, trace pink	1.0	medium strength, partially sintered	white, trace pink	2.0	good strength, partially sintered	off-white	5.0	excellent strength, fully sintered	off-white	6.5	dense and tough, partially vitrified	off-white	7.5	dense and tough, partially vitrified	yellow	X	X	X	X	X	X	-	-
BMP 592 (24-30')	grey	11.0	good strength, plastic	pale pink	0.5	good strength, partially sintered	pale pink	1.0	excellent strength, partially sintered	pale pink	3.0	excellent strength, fully sintered	dark stone	10.0	dense and tough, partially vitrified	stone	10.5	dense and tough, fully vitrified	-	X	X	X	X	X	-	-	-
BMP 597 (6-15')	pink	11.0	good strength, semi-plastic	pale terra cotta	1.0	good strength, partially sintered	pale terra cotta	2.0	excellent strength, partially sintered	pale brown, brown efflor-escence	5.0	excellent strength, fully sintered	dark brown, brown efflor-escence	6.0	dense and tough, partially vitrified	dark brown, brown efflor-escence	8.5	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	1
BMP 606 (12-27')	pink-brown	13.0	medium strength, semi-plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	5.0	good strength, fully sintered	dark brown	4.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 612 (21-30')	pink-grey	9.0	good strength, plastic	white	0.2	medium strength, partially sintered	white	1.0	good strength, partially sintered	white	4.0	excellent strength, fully sintered	off-white	7.5	dense and tough, fully vitrified	stone	8.0	dense and tough, fully vitrified	-	X	X	X	X	X	X	-	-
BMP 682 (0-9')	light brown	11.0	medium strength, non-plastic	brown	1.0	good strength, partially sintered	pale pink	1.5	good strength, partially sintered	brown	9.0	excellent strength, fully sintered	dark brown	15.0	dense and tough, partially vitrified	brown	12.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	2
BMP 685 (12-27')	pale pink	13.0	good strength, semi-plastic	pale pink	0.2	good strength, partially sintered	pale pink	0.5	good strength, partially sintered	pale pink	1.0	excellent strength, partially sintered	cream	4.0	dense and tough, fully sintered	cream	7.5	dense and tough, partially vitrified	-	X	X	X	X	X	-	-	-
BMP 721 (0-24')	brown	12.0	good strength, semi-plastic	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	3.5	excellent strength, fully sintered	brown	5.5	dense and tough, partially vitrified	dark brown	3.5	dense and tough, fully vitrified, semi-fused and bloated	-	X	-	-	-	-	-	-	-
BMP 735 (9-24')	light brown	7.0	medium strength, semi-plastic	pink	0.5	weak, partially sintered	pink	1.0	weak, partially sintered	pink	5.0	good strength, partially sintered	pink and brown	6.0	excellent strength, fully sintered	grey	7.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

1. The effect the firing efflorescence has on the glaze used would have to be checked by actual kiln tests.
2. It would be best to admix grog, sand or siliceous clay to reduce shrinkage.

TABLE IX..... continued

25.

Samples from Minor Clay Occurrences .....continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C			Fired at 1,000°C			Fired at 1,100°C			Fired at 1,200°C			Fired at 1,300°C			Efflorescence	Suitable for								
				Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment	Colour	Shrinkage from air dried %	Comment		Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 783 (0-21')	dark grey	7.0	good strength, semi-plastic	white	0.5	medium strength, partially sintered	white	1.0	medium strength, partially sintered	white	2.0	good strength, partially sintered	white	5.5	good strength, partially sintered	off-white	7.5	excellent strength, fully sintered	-	X	X	X	X	X	X	-	-
BMP 786 (0-12')	faded khaki	7.0	good strength, semi-plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	excellent strength, fully sintered	brick red	5.5	dense and tough, partially vitrified	dark brown	3.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 842 (3-12')	grey-brown	5.0	good strength, semi-plastic	terra cotta	4.0	medium strength, partially sintered	terra cotta	5.0	medium strength, partially sintered	terra cotta	7.0	good strength, partially sintered	brown	10.0	good strength, partially vitrified	brown	7.0	excellent strength, fully vitrified, slightly bloated	-	X	X	X	X	-	-	-	-
BMP 844 (0-12')	grey-brown	11.0	good strength, plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	brown	3.0	good strength, fully sintered	brown	5.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 844 (12-30')	brown	6.0	good strength, non-plastic	terra cotta	0.5	medium strength, slightly sintered	terra cotta	1.0	medium strength, slightly sintered	terra cotta	2.0	medium strength, partially sintered	dark terra cotta	3.0	good strength, partially vitrified	dark brown	—	partly fused, bloated	-	X	-	-	-	-	X	-	-
BMP 845 (3-15')	brown	12.0	good strength, plastic	terra cotta	0.5	good strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	dark terra	3.0	excellent strength, fully sintered	brown	4.0	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 845 (15-27')	grey	9.0	good strength, semi-plastic	buff	0.2	medium strength, slightly sintered	buff	0.5	good strength, partially sintered	buff	1.0	good strength, partially sintered	pale terra cotta	4.0	good strength, fully sintered	grey-brown	5.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 845 (27-42')	brown	5.0	medium strength, non-plastic	terra cotta	0.5	weak, friable	terra cotta	1.0	medium strength, slightly sintered	terra cotta	2.0	good strength, partially sintered	dark terra cotta	3.0	excellent strength, partially vitrified	dark brown	—	dense and tough, fully vitrified, slightly bloated	-	X	X	X	X	-	-	-	-
BMP 846 (3-9')	brown	7.5	good strength, non-plastic	terra cotta	0.2	weak, slightly sintered	terra cotta	0.7	medium strength, partially sintered	terra cotta	1.0	medium strength, partially sintered	terra cotta	1.5	medium strength, partially vitrified	terra cotta	2.5	good strength, partially sintered	-	X	-	-	-	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE IX..... continued

Samples from Minor Clay Occurrences..... continued

* Location	Colour	Shrinkage %	Strength and Type	Fired at 900°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,000°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,100°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,200°C: Colour	Shrinkage from air dried %	Comment	Fired at 1,300°C: Colour	Shrinkage from air dried %	Comment	Efflorescence	Suitable for: Bricks	Tiles	Pipes	Common Pottery	Whiteware	Pottery	Bloating	Remarks
BMP 846 (9-36')	light brown	5.0	medium strength, non-plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, fully sintered	terra cotta	3.0	excellent strength, partially vitrified	dark brown	—	partly fused, bloated	-	X	X	X	X	-	-	X	-
BMP 850 (3-18')	light brown	2.5	weak, friable, non-plastic	terra cotta	0.2	weak, friable	terra cotta	0.4	weak, slightly sintered	terra cotta	0.6	medium strength, partially sintered	brick red	1.0	good strength, fully sintered	brick red	2.5	excellent strength, partially vitrified	brown	-	-	-	-	-	-	-	-
BMP 850 (21-30')	light brown	6.5	good strength, semi-plastic	terra cotta	0.3	medium strength, partially sintered	terra cotta	0.5	good strength, partially sintered	terra cotta	0.8	good strength, partially sintered	brick red	1.3	excellent strength, fully sintered	dark brown	4.5	dense and tough, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 854 (3-15')	terra cotta	7.0	good strength, non-plastic	terra cotta	0.5	medium strength, partially sintered	terra cotta	1.0	good strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	excellent strength, fully sintered	dark brown	4.0	excellent strength, partially vitrified	-	X	X	X	X	-	-	-	-
BMP 855 (3-24')	terra cotta	9.5	good strength, non-plastic	terra cotta	0.3	weak, slightly sintered	terra cotta	0.7	medium strength, partially sintered	terra cotta	1.0	medium strength, partially sintered	brown	1.5	good strength, fully sintered	brick red	2.5	excellent strength, partially vitrified	-	X	-	-	-	-	-	-	-
BMP 869 (3-15')	light brown	10.0	good strength, semi-plastic	terra cotta	1.0	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	terra cotta	3.0	excellent strength, partially sintered	terra cotta	6.5	excellent strength, fully sintered	dark brick red	9.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 882 (9-18')	grey-brown	6.0	good strength, semi-plastic	terra cotta	1.0	medium strength, slightly sintered	terra cotta	1.5	medium strength, partially sintered	terra cotta	2.0	good strength, partially sintered	dark brown	3.0	excellent strength, partially vitrified	dark brown	4.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-
BMP 884 (3-12')	grey	10.0	good strength, plastic	terra cotta	0.2	good strength, partially vitrified	terra cotta	0.5	good strength, partially vitrified	terra cotta	1.0	excellent strength, partially vitrified	dark brown	2.0	dense and tough, partially vitrified	dark brown	3.0	dense and tough, fully vitrified	-	X	X	X	X	-	-	-	-

* Logs of drillholes from which samples were taken are given in Table VIII.

TABLE X

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS

1. Portions 52-55, Parish of Oxley (Oxley Creek)

Logs by: B. R. Houston

BMP 1471 (Auger)
0–17 ft LOAM: buff.
17–20 ft SAND: fine-grained, yellow, clayey.
20–23 ft CLAY: grey, very sandy.
Remarks: Seepage (17 ft).

BMP 1472 (Auger)
0– 2 ft SOIL.
2– 9 ft LOAM: buff.
9–13 ft CLAY: grey, silty.
13–21 ft SAND: yellow, coarse-grained, clayey.
21–23 ft CLAY: grey, very sandy; pebbly.

BMP 1473 (Auger)
0–10 ft CLAY: grey, plastic.
10–14 ft SAND: fine-grained, buff to light grey.
14–20 ft CLAY: brown, sandy.

BMP 1474 (Auger)
0–15 ft LOAM: red-brown, rich.
15–18 ft SAND: medium-grained, buff.
18–20 ft CLAY: grey, plastic.

BMP 1475 (Auger)
0– 2 ft SOIL.
2–10 ft LOAM: buff.
10–14 ft SAND: buff, fine- to medium-grained, very clayey; with clay bands (grey, plastic) and sandstone nodules
14–17 ft CLAY: grey, plastic.

BMP 1476 (Auger)
0– 2 ft SOIL
2–11 ft LOAM: buff.
11–13 ft SAND: medium- to coarse-grained, red, clayey.
13–17 ft SAND: medium-grained, grey, clayey.
17–18 ft 6 in. CLAY: grey, plastic.
18 ft 6 in.–24 ft 6 in. SAND: fine- to medium-grained, buff, clayey.
24 ft 6 in.–26 ft SANDSTONE: yellow, coarse-grained, pebbly, decomposed.

BMP 1477 (Auger)
0– 3 ft SOIL.
3–12 ft LOAM: buff.
12–19 ft SAND: buff, fine- to coarse-grained.
19–20 ft SANDSTONE: coarse-grained, yellow, clayey.
Remarks: Water (14 ft).

BMP 1478 (Auger)
0– 2 ft SOIL.
2–13 ft LOAM: buff.
13–17 ft SAND: very fine- to medium-grained, red, slightly clayey.
17–20 ft CLAY: grey, sandy.
Remarks: Water (16 ft).

BMP 1479 (Auger)
0– 2 ft SOIL.
2– 8 ft CLAY: brown, plastic.
8–19 ft SAND: very fine-grained, clayey.
19–20 ft SANDSTONE: coarse-grained, buff, pebbly.
20–23 ft CLAY: grey, plastic, pebbly.
Remarks: Water (18 ft).

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1480 (Auger)
0– 2 ft SOIL.
2–17 ft CLAY: brown, plastic.
17–20 ft CLAY: grey, plastic, very sandy (medium-grained).
Remarks: Water (17 ft).

BMP 1481 (Auger)
0–20 ft CLAY: buff, brown and grey.

BMP 1482 (Auger)
0–13 ft LOAM: red to yellow, rich.
13–20 ft CLAY: grey, plastic.

BMP 1483 (Auger)
0– 5 ft LOAM: buff.
5–11 ft CLAY: grey-brown.
11–14 ft SAND: grey, very silty, medium-grained.
14–20 ft CLAY: grey, plastic.

BMP 1484 (Auger)
0– 2 ft SOIL.
2– 5 ft CLAY: brown.
5–21 ft SAND: buff, medium-grained, very clayey.
21–24 ft CLAY: light grey.
24–26 ft SAND: buff, coarse-grained, pebbly, silty.
Remarks: Water (5 ft).

BMP 1485 (Auger)
0– 2 ft SOIL.
2–13 ft LOAM: red-brown.
13–23 ft SAND: buff, coarse-grained.
23–26 ft SAND: light grey, coarse-grained, very silty.
Remarks: Water (13 ft).

BMP 1486 (Auger)
0– 2 ft SOIL.
2–15 ft LOAM: buff.
15–28 ft SAND: medium-grained, buff.
28–29 ft CLAY: grey, pebbly.
Remarks: Water (15 ft).

BMP 1487 (Auger)
0– 2 ft SOIL.
2–10 ft SILTSTONE: buff.
10–25 ft SAND: medium-grained, buff, slightly clayey.
25–26 ft CLAY: grey, plastic.
Remarks: Water (10 ft).

BMP 1488 (Auger)
0– 5 ft SOIL.
5–15 ft CLAY: brown, semi-plastic.
15–22 ft SAND: buff, medium-grained, very silty; pebbly, 21–22 ft.
22–23 ft CLAY: grey, plastic.

BMP 1489 (Auger)
0– 2 ft SOIL.
2–10 ft LOAM: buff.
10–23 ft SAND: grey, coarse-grained, silty in part; pebbly at base.
Remarks: Water (14 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1490 (Auger)

0–14 ft LOAM: buff.
14–21 ft SAND: coarse-grained, grey, silty.
21–23 ft CLAY: grey, sandy.

BMP 1491 (Auger)

0– 2 ft SOIL.
2–17 ft CLAY: brown.
17–23 ft SAND: grey, coarse-grained, slightly silty.

BMP 1492 (Auger)

0–13 ft CLAY: brown, sandy.
13–26 ft SAND: buff, coarse-grained, very clayey.
Remarks: Water (13 ft).

BMP 1493 (Auger)

0– 2 ft SOIL: chocolate, rich.
2–14 ft LOAM: buff, rich.
14–17 ft SAND: fine-grained, yellow, clayey.
17–29 ft SAND: medium- to coarse-grained, buff.
Remarks: Water (15 ft).

BMP 1494 (Auger)

0– 2 ft SOIL.
2–11 ft CLAY: grey-brown, plastic, sandy.
11–17 ft SAND: yellow, clayey.
17–27 ft SAND: light grey, medium- to coarse-grained.
27–29 ft SAND: coarse-grained, light grey, very clayey; pebbly.
Remarks: Water (17 ft).

BMP 1495 (Auger)

0– 5 ft LOAM.
5–11 ft CLAY: dark grey, plastic.
11–17 ft SAND: fine-grained, yellow, clayey.
17–20 ft CLAY: grey, plastic, sandy.
Remarks: Water (12 ft).

BMP 1496 (Auger)

0– 2 ft SOIL.
2– 5 ft CLAY: grey-brown, plastic.
5–14 ft SAND: grey, very fine-grained, very clayey.
14–25 ft SAND: light grey, very coarse-grained.
25–26 ft CLAY: grey, plastic, very sandy.
Remarks: Water (13 ft).

BMP 1497 (Auger)

0– 2 ft SOIL.
2– 8 ft CLAY: brown, semi-plastic.
8–17 ft SAND: yellow, fine-grained, very clayey.
17–31 ft 6 in. SAND: light grey, coarse- to very coarse-grained, pebbly.
31 ft 6 in.–32 ft CLAY: light grey, plastic.
Remarks: Water (17 ft).

BMP 1498 (Auger)

0–17 ft CLAY: brown-grey, plastic.
17–23 ft SAND: grey to yellow, fine- to medium-grained, very clayey.
Remarks: Water (17 ft).

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1499 (Auger)

0– 2 ft SOIL.
2–14 ft CLAY: grey-brown, plastic, sandy.
14–23 ft SAND: light grey, medium- to coarse-grained.
23–26 ft SAND: light grey, medium- to coarse-grained, pebbly; silty.
Remarks: Water (14 ft).

BMP 1500 (Auger)

0– 2 ft SOIL.
2–17 ft CLAY: yellow-grey, plastic.
17–20 ft CLAY: grey, very sandy.
Remarks: Water (17 ft).

BMP 1501 (Auger)

0– 5 ft CLAY: brown, semi-plastic.
5–13 ft SAND: very fine-grained, clayey, light grey.
13–27 ft SAND: buff, medium- to coarse-grained.
27–29 ft SAND: light grey, very coarse-grained, clayey.
Remarks: Water (13 ft).

BMP 1502 (Auger)

0– 4 ft LOAM: brown.
4–17 ft CLAY: brown-grey, plastic.
17–25 ft SAND: light grey to buff, medium- to coarse-grained, pebbly.
25–26 ft CLAY: grey, plastic, sandy.
Remarks: Water (18 ft).

BMP 1503 (Auger)

0– 5 ft LOAM.
5–11 ft CLAY: brown, plastic.
11–17 ft LOAM: brown; with clay bands.
17–20 ft SAND: very fine-grained, yellow, very clayey.
20–26 ft SAND: light grey, medium- to coarse-grained, pebbly; with small clayey bands.
Remarks: Water (17 ft).

BMP 1504 (Auger)

0–11 ft LOAM: brown.
11–13 ft CLAY: blue-grey, plastic.
13–28 ft SAND: light grey, very coarse-grained; silty towards base.
28–29 ft CLAY: grey, plastic, very sandy.
Remarks: Water (13 ft).

BMP 1505 (Auger)

0–11 ft CLAY: grey, plastic.
11–15 ft CLAY: yellow, very sandy (fine-grained).
15–27 ft SAND: medium- to coarse-grained, light grey; silty and pebbly towards base.
27–29 ft CLAY: grey, plastic.
Remarks: Water (15 ft).

BMP 1506 (Auger)

0–11 ft SOIL.
11–14 ft LOAM: buff.
14–24 ft SAND: fine- to medium-grained, buff.
24–30 ft SAND: grey, coarse-grained.
30–32 ft CLAY: silty; with gravel.
Remarks: Water (15 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1507 (Auger)

0– 6 ft CLAY: brown, plastic.
6–11 ft SAND: yellow-brown, very fine-grained, clayey.
11–21 ft SAND: brown to yellow, medium- to coarse-grained, slightly silty.
21–27 ft SAND: medium- to coarse-grained, grey, very silty.
27–29 ft CLAY: grey, very sandy; with gravel.
Remarks: Water (11 ft).

BMP 1508 (Auger)

0– 8 ft CLAY: brown, plastic.
8–17 ft SAND: buff, fine- to medium-grained, silty.
17–28 ft SAND: grey, medium- to coarse-grained, very silty.
28–29 ft GRAVEL.
Remarks: (Water 14 ft).

BMP 1509 (Auger)

0–11 ft LOAM: buff.
11–23 ft CLAY: grey, very sandy.

BMP 1510 (Auger)

0– 9 ft LOAM: buff.
9–15 ft SAND: fine-grained, very clayey, brown.
15–21 ft SAND: fine-grained, very silty; with clayey bands.
21–23 ft CLAY: grey, sandy.

BMP 1511 (Auger)

0–13 ft CLAY: grey, plastic; sandy in part.
13–18 ft SAND: fine-grained, buff, very clayey.
18–20 ft CLAY: grey, plastic.

BMP 1512 (Auger)

0– 5 ft LOAM.
5–14 ft CLAY: grey, plastic.
14–17 ft SAND: buff, very fine-grained, very clayey.

BMP 1513 (Auger)

0– 2 ft CLAY: dark brown.
2–14 ft LOAM: buff.
14–26 ft SAND: medium- to coarse-grained, buff to grey, silty.
26–26+ ft GRAVEL.
Remarks: Water (14 ft).

BMP 1514 (Auger)

0– 2 ft SOIL: dark brown.
2– 8 ft CLAY: brown, plastic, sandy.
8–16 ft CLAY: grey, plastic.
16–21 ft SAND: fine- to medium-grained, buff to grey, silty.
21–23 ft CLAY: grey, sandy.
Remarks: Water (14 ft).

BMP 1515 (Auger)

0– 2 ft SOIL.
2–12 ft LOAM: buff.
12–27 ft SAND: fine- to medium-grained, buff to grey, very silty.
27–29 ft CLAY: grey.
Remarks: Water (12 ft).

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1516 (Auger)

0– 2 ft CLAY: dark brown.
2–11 ft LOAM: buff.
11–20 ft SAND: fine-grained, brown, silty.
20–28 ft SAND: grey, medium-grained, very clayey.
28–29 ft GRAVEL: siliceous; grey, sandy CLAY matrix.
Remarks: Water (11 ft).

BMP 1517 (Bailer)

0–7 ft 11¼ in.	LOAM: buff.
7 ft 11¼ in.–9 ft 3¼ in.	SAND: brown, fine- to medium-grained, clayey.
9 ft 3¼ in.–10 ft 5 in.	SAND: brown, very coarse-grained, clayey.
10 ft 5 in.–10 ft 11¼ in.	SAND: brown, very fine-grained, silty.
10 ft 11¼ in.–13 ft 8¼ in.	SAND: grey, very coarse-grained, clayey; thin CLAY band near base.
13 ft 8¼ in.–14 ft 2 in.	SAND: grey, very coarse-grained, silty; clayey bands and coarse GRAVEL at base.
14 ft 2 in.–16 ft 1½ in.	SAND: grey, medium- to coarse-grained, very silty; GRAVEL at base.
16 ft 1½ in.–21 ft 3¼ in.	SAND: buff, fine- to medium-grained, silty.
21 ft 3¼ in.–24 ft 8 in.	SAND: grey, coarse-grained, clayey to very clayey; few coarse pebbles.
24 ft 8 in.–25 ft 9 in.	CLAY: grey, sandy.

BMP 1518 (Bailer)

0–10 ft 7¼ in.	Open hole; no recovery.
10 ft 7¼ in.–16 ft 6¾ in.	SAND: buff, fine-grained, silty; thin bed coarse-grained about 13 ft 8 in.
16 ft 6¾ in.–17 ft 9¼ in.	SAND: grey, coarse-grained, clayey; few sandstone nodules.
17 ft 9¼ in.–21 ft 5¾ in.	SAND: buff, coarse-grained, silty.
21 ft 5¾ in.–22 ft 10½ in.	SAND: buff, fine- to medium-grained, very clayey.
22 ft 10½ in.–23 ft 3 in.	SAND: buff, medium-grained, very clayey.
23 ft 3 in.–24 ft 2¾ in.	SAND: grey, coarse-grained, very clayey.
24 ft 2¾ in.–26 ft 4½ in.	SAND: buff, fine- to medium-grained; about 9 in. sandy CLAY at top; pebbly at base.
26 ft 4½ in.–27 ft 1¾ in.	SAND: buff, coarse-grained, clayey; pebbly.
27 ft. 1¾ in.–27 ft 11¼ in.	SAND: buff, very coarse-grained, pebbly.
27 ft 11¼ in.–29 ft 1¾ in.	SAND: buff, very coarse-grained, slightly silty.
29 ft 1¾ in.–30 ft 7¾ in.	CLAY: grey, plastic, gravelly; very coarse-grained, buff SAND at top.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

1. Portions 52-55, Parish of Oxley (Oxley Creek)—continued

BMP 1519 (Bailer)

0–11 ft 1¼ in.	LOAM.
11 ft 1¼ in.–20 ft 11¼ in.	SAND: buff, fine- to medium-grained, silty.
20 ft 11¼ in.–24 ft 0¼ in.	SAND: buff, medium-grained.
24 ft 0¼ in.–29 ft 10½ in.	SAND: grey, medium- to coarse-grained, clayey; pebbly (25 ft 4 in.–27 ft 4 in.).
29 ft 10½ in.–31 ft 4 in.	CLAY: grey-buff, sandy (fine- to medium-grained).

BMP 1520 (Bailer)

0–10 ft 10¾ in.	CLAY: grey, plastic.
10 ft 10¾ in.–13 ft 11¼ in.	SAND: buff, fine- to very fine-grained, clayey to very clayey.
13 ft 11¼ in.–17 ft 5 in.	CLAY: grey to buff, sandy (fine-grained).
17 ft 5 in.–17 ft 8¾ in.	SAND: grey, fine- to medium-grained, silty.
17 ft 8¾ in.–28 ft 11 in.	SAND: light grey, very coarse-grained, siliceous; pebbly at 20 ft 2 in. and 23 ft 4 in.; very clayey and pebbly (26 ft 9 in.–27 ft 10 in.).
28 ft 11 in.–29 ft 3 in.	CLAY.

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2. Portion 358A, Parish of Oxley (Oxley Creek)

Logs by: B. R. Houston

BMP 1427 (Auger)
0– 2 ft SOIL: fine-grained, brown.
2–17 ft LOAM: buff.
17–27 ft SAND: coarse-grained, buff.
27–30 ft CLAY: grey, sandy.
Remarks: Seepage (20 ft)

BMP 1428 (Auger)
0– 2 ft SOIL: black.
2–15 ft LOAM: buff.
15–30 ft SAND: grey, coarse-grained, pebbly.

BMP 1429 (Auger)
0– 2 ft SOIL.
2–11 ft LOAM: buff.
11–14 ft SAND: fine-grained, buff.
14–21 ft SAND: coarse-grained, grey.
21–23 ft CLAY.

BMP 1430 (Auger)
0– 2 ft SOIL.
2– 8 ft LOAM: buff.
8–11 ft SAND: yellow, medium-grained.
11–21 ft SAND: grey, coarse-grained.
21–22 ft GRAVEL.
22–23 ft CLAY.

BMP 1431 (Auger)
0– 2 ft SOIL.
2– 9 ft LOAM: buff.
9–11 ft SAND: very fine-grained, buff.
11–22 ft SAND: coarse-grained, grey.
22–23 ft GRAVEL.

2. Portion 358A, Parish of Oxley (Oxley Creek)—continued

BMP 1432 (Auger)
0– 2 ft SOIL.
2–11 ft LOAM: brown.
11–24 ft SAND: grey, silty.
24–26 ft GRAVEL.
26–26+ ft CLAY.

BMP 1433 (Auger)
0– 5 ft SOIL: rich brown.
5–12 ft SAND: medium-grained, buff.
12–21 ft SAND: grey, coarse- to very coarse-grained.
21–26 ft SAND: grey, silty.
26–26+ft CLAY.
Remarks: Water (12 ft).

BMP 1434 (Auger)
0– 5 ft SAND: buff, clayey.
5– 8 ft CLAY: light grey, plastic.
8–17 ft SAND: coarse-grained, grey.
17–20 ft CLAY: light grey.
Remarks: Water (3 ft).

BMP 1435 (Auger)
0– 2 ft LOAM: buff.
2–20 ft SILT: grey, sandy.
Remarks: Water (2 ft).

BMP 1436 (Auger)
0– 2 ft SOIL: brown.
2–14 ft LOAM: buff.
14–23 ft SAND: fine- to medium-grained, buff-grey passing into
CLAY: grey, plastic.

BMP 1437 (Auger)
0– 2 ft SOIL: brown.
2–16 ft LOAM: buff.
16–20 ft LOAM: very clayey.

BMP 1438 (Auger)
0– 5 ft SOIL.
5–16 ft CLAY: grey-brown, plastic.
16–25 ft SAND: fine- to medium-grained, grey, slightly clayey.
25–26 ft GRAVEL.
26–26+ ft CLAY.

BMP 1439 (Auger)
0– 2 ft SOIL: brown.
2–14 ft LOAM: buff, slightly clayey.
14–22 ft SAND: fine- to medium-grained, buff.
22–28 ft SAND: medium- to coarse-grained, grey, slightly silty.
28–29 ft CLAY: grey, plastic.
Remarks: Water (14 ft).

BMP 1440 (Auger)
0– 2 ft SOIL.
2–18 ft CLAY: brown-grey, plastic.
18–20 ft SAND: very fine-grained, grey, clayey.

BMP 1441 (Auger)
0– 2 ft SOIL.
2–13 ft CLAY: grey, plastic.
13–20 ft SAND: very fine-grained, grey, clayey.
20–20+ ft GRAVEL.
Remarks: Seepage (18 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

2. Portion 358A, Parish of Oxley (Oxley Creek)—continued

BMP 1442 (Auger)
0– 2 ft SOIL.
2–13 ft LOAM: buff.
13–21 ft SAND: buff, fine- to medium-grained.
21–26 ft SAND: grey, silty, medium- to coarse-grained.
Remarks: Water (15 ft).

BMP 1443 (Auger)
0– 2 ft SOIL.
2–14 ft CLAY: red-grey, plastic.
14–20 ft CLAY: yellow, sandy (medium- to coarse-grained); with sandstone pebbles.

BMP 1444 (Auger)
0– 2 ft SOIL.
2–17 ft CLAY: grey to red, plastic.
17–20 ft SAND: buff, very fine-grained, clayey.

BMP 1445 (Auger)
0– 2 ft SOIL.
2–20 ft CLAY: grey, plastic.

BMP 1446 (Auger)
0– 2 ft SOIL.
2–15 ft CLAY: grey, plastic.
15–18 ft CLAY: grey, sandy.
18–20 ft CLAY: grey.

BMP 1447 (Auger)
0– 2 ft SOIL.
2–17 ft CLAY: grey to red, plastic.
17–20 ft CLAY: buff, silty.
20–29 ft SAND: buff, fine- to medium-grained; silty towards base.
Remarks: Water (20 ft).

BMP 1448 (Auger)
0–12 ft CLAY: red-grey.
12–23 ft CLAY: yellow, very sandy.
Remarks: Water (20 ft).

BMP 1449 (Auger)
0–14 ft CLAY: grey, plastic.
14–20 ft SAND: fine-grained, buff to yellow, clayey.
Remarks: Water (14 ft).

BMP 1450 (Auger)
0– 2 ft SOIL.
2–14 ft CLAY: grey-brown, plastic.
14–20 ft SAND: fine-grained, yellow, clayey.

BMP 1451 (Auger)
0– 2 ft SOIL.
2–11 ft CLAY: brown, plastic.
11–20 ft SAND: fine- to medium-grained, buff, silty.
20–23 ft CLAY.
Remarks: Water (11 ft).

BMP 1452 (Auger)
0–17 ft CLAY: grey-red, plastic.
17–20 ft SAND: very fine-grained, buff.

2. Portion 358A, Parish of Oxley (Oxley Creek)—continued

BMP 1453 (Auger)
0– 5 ft SOIL.
5–14 ft CLAY: grey, plastic.
14–29 ft SAND: fine- to medium-grained, yellow-grey, clayey.
Remarks: Water (14 ft).

BMP 1454 (Auger)
0– 2 ft SOIL.
2– 4 ft CLAY.
4–11 ft SAND.
11–28 ft SAND: fine- to medium-grained, yellow-brown.
28–29 ft GRAVEL.
Remarks: Water (11 ft).

BMP 1455 (Auger)
0–17 ft CLAY: brown, plastic.
17–20 ft CLAY: light grey, coarse-grained, sandy; with siliceous pebbles.

BMP 1456 (Auger)
0–14 ft CLAY: grey-brown, plastic.
14–17 ft CLAY: fine- to medium-grained, buff, clayey.
17–20 ft SAND: fine-grained.

BMP 1457 (Auger)
0–14 ft CLAY: brown-grey, plastic.
14–17 ft SAND: fine- to medium-grained, light grey.
17–20 ft SAND: yellow-grey, very clayey.

BMP 1458 (Auger)
0– 2 ft SOIL.
2–11 ft LOAM: buff.
11–22 ft SAND: fine- to medium-grained; clayey below 19 ft.
22–23 ft GRAVEL.
Remarks: Water (11 ft).

BMP 1459 (Auger)
0–14 ft CLAY: brown, plastic.
14–20 ft SAND: fine- to medium-grained, yellow to buff, very clayey; with decomposed sandstone.
Remarks: Water (14 ft).

BMP 1460 (Auger)
0–20 ft CLAY: brown, plastic.

BMP 1461 (Auger)
0–14 ft CLAY: brown, plastic.
14–20 ft SAND: yellow-grey, fine- to medium-grained, very clayey.

BMP 1462 (Auger)
0– 2 ft SOIL.
2–11 ft LOAM: buff.
11–23 ft SAND: fine- to medium-grained, yellow, slightly clayey.
23–26 ft CLAY: grey, sandy.
Remarks: Water (11 ft).

BMP 1463 (Auger)
0– 2 ft SOIL.
2–11 ft LOAM: buff.
11–22 ft SAND: fine- to medium-grained, yellow, slightly clayey.
22–23 ft GRAVEL: clayey.
Remarks: Water (10 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

2. Portion 358A, Parish of Oxley (Oxley Creek)—continued

BMP 1464 (Auger)
0– 2 ft SOIL.
2–14 ft CLAY: grey, plastic.
14–20 ft CLAY: yellow, very sandy (medium-grained).

BMP 1465 (Auger)
0– 8 ft CLAY: grey to red.
8–23 ft SANDSTONE: fine-grained, yellow, argillaceous.
Remarks: Water (20 ft).

BMP 1466 (Auger)
0– 7 ft LOAM: buff.
7–16 ft CLAY: brown, sandy.
16–20 ft SAND: buff, fine- to medium-grained, slightly clayey.
Remarks: Water (16 ft).

BMP 1467 (Auger)
0–11 ft CLAY: grey.
11–19 ft SAND: buff, medium- to coarse-grained.
19–20 ft CLAY: buff, very sandy; pebbly in part.
Remarks: Water (11 ft).

BMP 1468 (Auger)
0– 9 ft LOAM: buff, very clayey.
9–20 ft CLAY: grey, plastic.

BMP 1469 (Auger)
0– 8 ft LOAM: buff.
8–17 ft CLAY: grey, plastic.
17–20 ft CLAY: grey, sandy.

BMP 1470 (Auger)
0- 8 ft CLAY: grey, plastic.
8–26 ft SAND: fine- to medium-grained, yellow, clayey.
26–29 ft CLAY: grey, very sandy (medium- to coarse-grained); with pebbles.

BMP 1522 (Bailer)

0–14 ft 0 in.	LOAM.
14 ft 0 in.–15 ft 2¾ in.	SAND: brown, fine- to coarse grained, silty.
15 ft 2¾ in.–16 ft 0¾ in.	SAND: grey, fine- to medium-grained, clayey.
16 ft 0¾ in.–17 ft 1¾ in.	SAND: grey, medium- to coarse-grained, very clayey; pebbly.
17 ft 1¾ in.–18 ft 1½ in.	CLAY: grey, sandy (fine- to medium-grained) and pebbly.
18 ft 1½ in.–19 ft 1 in.	SAND: grey, fine- to medium-grained, clayey.
19 ft 1 in.–19 ft 6¾ in.	SAND: grey, fine- to medium-grained, silty, pebbly.
19 ft 6¾ in.–21 ft 1 in.	SAND: grey, fine- to medium-grained, very clayey; 6 in. grey sandy CLAY at base.
21 ft 1 in.–23 ft 9¾ in.	SAND: grey, medium- to coarse-grained, very clayey.
23 ft 9¾ in.–24 ft 1¾ in.	CLAY: plastic.

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek)

Logs by: J. D. Sawers

BMP 1377 (Auger)
0– 2 ft SOIL: brown, sandy.
2– 5 ft CLAY: grey-brown, semi-plastic.
5–11 ft CLAY: brown, sandy.
11–14 ft CLAY: brown to red-brown to grey, sandy.
14–20 ft CLAY: brown to grey, semi-plastic; sandy in part.

BMP 1378 (Auger)
0– 2 ft SAND: silty, grey.
2–18 ft CLAY: sandy, brown.
18–20 ft SAND: clayey, grey, pebbly.

BMP 1379 (Auger)
0–11 ft CLAY: sandy, brown.
11–25 ft SAND: grey, silty, medium- to coarse-grained.
25–32 ft CLAY: grey, plastic, pebbly.

BMP 1380 (Auger)
0– 2 ft SOIL: grey-brown, sandy.
2– 9 ft CLAY: grey, plastic.
9–15 ft SANDSTONE: grey, decomposed.
15–26 ft CLAY: grey, sandy; some pebbles.

BMP 1381 (Auger)
0– 1 ft SOIL: grey-brown, sandy.
1– 5 ft CLAY: brown.
5–19 ft SANDSTONE: grey to brown, decomposed.
19–20 ft CLAY: grey, sandy; some pebbles.

BMP 1382 (Auger)
0–27 ft LOAM: brown, sandy (fine- to medium-grained).
27–32 ft CLAY: grey to brown, plastic.

BMP 1383 (Auger)
0–20 ft LOAM: brown, sandy; decomposed sandstone bands near top.
20–23 ft SAND: grey, medium-grained, clayey.
23–26 ft CLAY: brown-grey, plastic.
Remarks: Water (20 ft).

BMP 1384 (Auger)
0– 9 ft LOAM: buff, sandy (fine- to medium-grained).
9–18 ft SAND: buff to grey, fine- to medium-grained, silty.
18–21 ft SAND: grey, medium- to coarse-grained, pebbly, clayey.
21–23 ft CLAY.

BMP 1385 (Auger)
0– 2 ft SOIL: grey, sandy.
2– 8 ft LOAM: brown, sandy.
8–21 ft SAND: brown, fine- to medium-grained.
21–24 ft SAND: grey, coarse-grained, pebbly.
24–26 ft CLAY: yellow-brown, plastic.

BMP 1386 (Auger)
0– 2 ft LOAM: grey to brown, sandy.
2–26 ft SAND: grey, fine- to medium-grained, silty, slightly clayey
passing into
SAND: grey, fine- to medium-grained, clayey.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1387 (Auger)

0– 2 ft SOIL: brown, sandy.
2– 5 ft SANDSTONE: brown to grey, decomposed.
5– 8 ft SAND: brown, medium-grained, slightly silty; pebbly in part.
8–11 ft SAND: brown.
11–15 ft SAND: grey, silty.
15–20 ft SAND: grey, medium- to coarse-grained, pebbly; slightly silty.

BMP 1388 (Auger)

0–14 ft LOAM: brown, sandy.
14–20 ft SAND: brown, fine- to medium-grained, silty to slightly silty.
20–24 ft SAND: grey, coarse-grained; few small pebbles.
24–26 ft CLAY: brown to yellow-grey, plastic.

BMP 1389 (Auger)

0– 8 ft LOAM: brown, sandy.
8–23 ft SAND: brown, silty passing into grey, fine- to medium-grained, silty to very silty.

Remarks: Water (8 ft).

BMP 1390 (Auger)

0–12 ft LOAM: yellow-brown, sandy.
12–27 ft SAND: yellow-brown, medium- to coarse-grained, silty passing into grey, coarse-grained.
27–29 ft CLAY: grey and yellow, silty.

BMP 1391 (Auger)

0– 2 ft LOAM: grey-brown, sandy.
2– 5 ft SAND: brown, fine-grained, silty.
5–11 ft CLAY: grey to brown, very silty.
11–29 ft SAND: grey, fine- to medium-grained, silty; large "billy" pebbles, 27–29 ft.

BMP 1392 (Auger)

0–20 ft SAND: brown, fine-grained, silty passing into grey, medium- to coarse-grained; silty.

BMP 1393 (Auger)

0– 8 ft CLAY: brown, silty.
8–14 ft LOAM: yellow-brown, sandy.
14–22 ft SAND: brown, fine- to medium-grained, slightly silty passing into grey, medium- to coarse-grained; pebbly in part.

BMP 1394 (Auger)

0– 2 ft SOIL: grey-brown, sandy.
2–11 ft CLAY: brown to light grey, silty.
11–18 ft SAND: brown, silty.
18–22 ft SAND: grey, medium- to coarse-grained, clean.
22–23 ft CLAY: grey, silty.

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1395 (Auger)

0– 5 ft CLAY: brown, silty.
5–14 ft LOAM: yellow-brown, sandy (fine- to medium-grained).
14–32 ft SAND: brown, fine- to medium-grained, slightly silty passing into grey, coarse-grained; coarse GRAVEL at base.
32–33 ft CLAY.

BMP 1396 (Auger)

0–14 ft CLAY: grey, silty.
14–30 ft SAND: grey-brown, fine- to medium-grained, silty passing into grey, medium- to coarse-grained; pebbly in part.
30–32 ft CLAY: yellow-brown, plastic.

BMP 1397 (Auger)

0– 2 ft CLAY: brown, silty.
2– 8 ft LOAM: brown, sandy.
8–15 ft CLAY: brown, silty.
15–28 ft SAND: brown to grey, silty, fine- to medium-grained.
28–29 ft CLAY: brown, silty.

BMP 1398 (Auger)

0–18 ft LOAM: brown, sandy.
18–23 ft SAND: brown, medium-grained, slightly silty.
23–29 ft SAND: grey, medium- to coarse-grained.
29–32 ft CLAY: grey, silty.

BMP 1399 (Auger)

0– 8 ft CLAY: brown, silty.
8–14 ft LOAM: brown, sandy.
14–20 ft SAND: brown to grey, fine- to medium-grained, silty.
20–25 ft SAND: grey, medium-grained, pebbly.
25–26 ft CLAY: yellow, plastic.

BMP 1400 (Auger)

0– 2 ft SOIL: grey, sandy.
2– 8 ft CLAY: brown to grey, silty.
8–13 ft LOAM: brown, sandy.
13–24 ft SAND: brown to grey, fine- to medium-grained- lightly silty passing into brown to grey, medium- to coarse-grained; pebbly in part.
24–26 ft CLAY: brown, silty.

BMP 1401 (Auger)

0– 2 ft SOIL: grey, sandy.
2–14 ft LOAM: brown, sandy.
14–36 ft SAND: grey, medium-grained, silty passing into grey, coarse-grained, pebbly.
36–38 ft CLAY: grey, plastic.

BMP 1402 (Auger)

0–14 ft CLAY: brown, silty.
14–20 ft SAND: brown to grey, fine- to medium-grained; slightly silty at top.
20–23 ft SAND: grey, very silty.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1403 (Auger)

0–17 ft LOAM: brown to buff, sandy.
17–27 ft SAND: buff, fine- to medium-grained, slightly silty passing into grey, medium- to coarse-grained, slightly silty.
27–32 ft CLAY: grey, plastic, sandy.

BMP 1404 (Auger)

0– 2 ft SOIL: grey, sandy.
2–14 ft LOAM: brown, sandy; coarser with depth.
14–24 ft SAND: brown, medium-grained, slightly silty passing into brown, coarse-grained passing into grey, slightly silty, coarse-grained.
24–29 ft CLAY: grey, silty.

BMP 1405 (Auger)

0– 2 ft SOIL: grey, sandy.
2–18 ft LOAM: buff to brown, sandy.
18–23 ft SAND: buff, coarse-grained.
23–26 ft CLAY: grey, sandy.

BMP 1406 (Auger)

0– 2 ft SOIL: dark brown, sandy.
2–14 ft LOAM: brown, sandy.
14–20 ft SAND: grey-brown, medium-grained, silty passing into grey, coarse-grained, silty.
20–23 ft CLAY: grey, sandy.
23–26 ft CLAY: yellow, slightly silty.

BMP 1407 (Auger)

0– 2 ft SOIL.
2–14 ft LOAM: brown, sandy passing into dark brown, sandy.
14–23 ft SAND: grey, medium-grained, silty, pebbly passing into medium- to coarse-grained.
23–26 ft CLAY.

BMP 1408 (Auger)

0– 2 ft SOIL: dark grey, sandy.
2–17 ft LOAM: buff to brown, sandy.
17–26 ft SAND: brown, medium-grained, slightly silty passing into grey, coarse-grained, becoming silty.
26–29 ft CLAY: grey, sandy, plastic.

BMP 1409 (Auger)

0– 2 ft SOIL: grey, sandy.
2–12 ft LOAM: dark brown, sandy.
12–26 ft SAND: brown, fine- to medium-grained, slightly silty passing into brown to grey, medium- to coarse-grained passing into grey, medium- to coarse-grained; slightly silty near bottom; small pebbles in part.
26–32 ft CLAY: yellow, plastic, slightly sandy.

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1410 (Auger)

0– 2 ft SOIL: grey, sandy.
2–11 ft LOAM: brown, clayey passing into brown to buff, sandy.
11–26 ft SAND: buff to grey, fine- to medium-grained, slightly silty passing into buff, medium- to coarse-grained passing into grey- medium- to coarse-grained.
26–29 ft CLAY: grey, silty.

BMP 1411 (Auger)

0– 2 ft SOIL: grey, sandy.
2– 5 ft LOAM: brown, clayey.
5–14 ft SAND: fine-grained, buff.
14–26 ft SAND: buff, medium- to coarse-grained passing into grey, coarse-grained.
26–29 ft CLAY: grey and yellow, silty.

BMP 1412 (Auger)

0– 2 ft SOIL: dark brown.
2– 8 ft LOAM: buff to brown, sandy to clayey.
8–11 ft CLAY: brown, silty.
11–23 ft SAND: buff to grey, fine- to medium-grained, silty passing into grey, medium- to coarse-grained; with small siliceous pebbles passing into GRAVEL.
23–26 ft CLAY: grey, silty and sandy.

BMP 1413 (Auger)

0– 2 ft SOIL: brown, clayey.
2– 8 ft LOAM: yellow-brown, clayey.
8–17 ft CLAY: brown to grey, sandy; with decomposed SANDSTONE bands.

BMP 1414 (Auger)

0– 2 ft SOIL: dark brown, clayey.
2– 8 ft LOAM: brown to yellow-brown, clayey.
8–15 ft CLAY: yellow-brown to brown, silty, plastic.
15–23 ft SAND: buff, medium-grained, silty passing into grey, medium- to coarse-grained, silty, pebbly.

BMP 1415 (Auger)

0– 5 ft CLAY: grey to bluff, silty.
5– 8 ft SAND: grey, fine-grained, silty.
8–20 ft CLAY: grey, silty, plastic.

BMP 1416 (Auger)

0–20 ft CLAY: brown to grey, plastic.

BMP 1417 (Auger)

0–11 ft CLAY: grey-brown, plastic.
11–18 ft SAND: yellow-brown.
18–23 ft SAND: fine- to medium-grained, buff to grey, slightly silty; few pebbles (siliceous).
23–29 ft CLAY: yellow-brown to grey, sandy.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1418 (Auger)

0–21 ft CLAY: grey, slight brown mottling, plastic.
21–23 ft SAND: fine-grained, grey, silty.

BMP 1419 (Auger)

0–20 ft CLAY: grey to brown, plastic.
20–24 ft SAND: buff to grey, silty.

BMP 1420 (Auger)

0–11 ft CLAY: grey to brown, plastic passing into grey, becoming sandy.
11–14 ft LOAM: buff, sandy.
14–26 ft SAND: buff, fine-grained passing into grey, medium-grained, silty; with iron-stone pebbles.

BMP 1421 (Auger)

0– 8 ft CLAY.
8–23 ft SANDSTONE: decomposed, grey to buff, medium-grained, pebbly passing into white, fine-grained passing into decomposed, buff, medium- to coarse-grained passing into GRAVEL.

BMP 1422 (Auger)

0–14 ft CLAY: brown-grey, silty passing into grey, sandy.
14–20 ft SAND: grey, clayey.

BMP 1423 (Auger)

0–11 ft CLAY: brown-grey, sandy.
11–17 ft SAND: brown, fine- to medium-grained, silty.
17–20 ft CLAY: grey, silty.

BMP 1424 (Auger)

0– 2 ft SOIL: brown, sandy.
2– 5 ft LOAM: brown, clayey.
5– 8 ft SAND: buff, fine-grained, silty.
8–11 ft LOAM: brown, sandy.
11–15 ft SAND: buff, fine-grained, silty.
15–17 ft CLAY: brown, sandy.
Remarks: Water (17 ft).

BMP 1425 (Auger)

0– 2 ft SOIL: grey, sandy.
2–14 ft CLAY: brown to dark brown, semi-plastic.
14–24 ft SAND: grey, fine- to medium-grained, silty passing into buff, medium- to coarse-grained, silty passing into grey, coarse-grained, silty; with small pebbles.
24–26 ft CLAY: grey, silty.

3. Sub. 2 of Portion 356, Parish of Oxley (Oxley Creek) —continued

BMP 1426 (Auger)

0–16 ft LOAM: brown to dark brown, clayey passing into yellow-brown, sandy.
16–19 ft SAND: buff to grey, silty.
19–20 ft CLAY: brown.

BMP 1521 (Bailer)

0–14 ft 3¼ in.	LOAM.
14 ft 3¼ in.–18 ft 4 in.	SAND: brown, fine- to medium-grained, clayey; thin CLAY band near base.
18 ft 4 in.–19 ft 3 in.	SAND: light brown, coarse-grained, slightly silty.
19 ft 3 in.–21 ft 1¼ in.	SAND: grey, very coarse-grained, very clayey; few small pebbles at top.
21 ft 1¼ in.–22 ft 7¼ in.	CLAY: grey, sandy (fine- to medium-grained).
22 ft 7¼ in.–23 ft 5¼ in.	CLAY: light grey, plastic.

BMP 1672 (Auger)

0– 2 ft SOIL: black.
2–20 ft LOAM: yellow-brown.
20–23 ft SAND: coarse-grained, buff, clean.
23–29 ft SAND: coarse-grained, grey, slightly silty.
29–32 ft SAND: fine-grained, dark grey to black, very clayey.

BMP 1673 (Bailer)

0–10 ft 0 in.	Open hole; no recovery.
10 ft 0 in.–14 ft 7 in.	SAND: buff, fine- to medium-grained.
14 ft 7 in.–17 ft 0 in.	No recovery.
17 ft 0 in.–19 ft 3 in.	SAND: buff, fine- to medium-grained.
19 ft 3 in.–23 ft 7 in.	SAND: light grey, coarse-grained.
23 ft 7 in.–25 ft 8 in.	SAND: grey, coarse-grained, very clayey; abundant siliceous pebbles.

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4. Portion 283, Parish of Oxley, (Oxley Creek)

Logs by: B. A. Coxhead

BMP 1766 (Auger)

0– 5 ft LOAM: light grey and buff, sandy.
5–11 ft CLAY: buff, very sandy, plastic, passing into SAND: light grey, fine-grained, very clayey.
11–15 ft SAND: buff, very fine-grained, slightly clayey to clayey.
15–20 ft SAND: buff to grey, medium-grained, clayey to very clayey.
20–20+ ft CLAY: light grey, slightly sandy.
Remarks: Water (11 ft).

BMP 1767 (Auger)

0– 8 ft LOAM: cream to yellow; very sandy towards base.
8–11 ft SAND: buff, fine-grained, slightly clayey.
11–17 ft SAND: buff to mustard, fine- to medium-grained, clayey to very clayey.
17–20 ft CLAY: light grey and slightly ironstained brown, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1768 (Auger)

0– 2 ft LOAM: light grey.
2–10 ft SAND: buff, very fine- to fine-grained, slightly clayey to clayey.
10–18 ft CLAY: light grey, plastic, slightly sandy to sandy.
18–32 ft SAND: buff, very fine-grained, clayey; numerous sandy CLAY bands.
32–34 ft SAND: light buff, medium- to coarse-grained, clean.
34–38 ft SAND: light grey, coarse-grained, clayey to very clayey with numerous small pebbles; sandy CLAY at base.

BMP 1769 (Auger)

0– 5 ft LOAM: light grey and buff.
5–14 ft SAND: light grey, very clayey; clayey below 11 ft.
14–32 ft SAND: buff, very fine- to fine-grained, clayey; with sandy CLAY in part.
32–38 ft CLAY: grey-green, plastic, slightly sandy (coarse-grained to slightly pebbly).

Remarks: Water (14 ft).

BMP 1770 (Auger)

0– 8 ft LOAM: buff.
8–20 ft SAND: yellow-brown to buff, very fine- to fine-grained; slightly clayey, 8–12 ft.
20–24 ft CLAY: grey and red-brown, plastic.
24–26 ft CLAY: grey; with coarse-grained SAND.

BMP 1771 (Auger)

0– 4 ft LOAM: light grey to cream.
4– 8 ft SAND: buff, very fine- to fine-grained, silty to clayey.
8–12 ft CLAY: light grey, sandy.
12–18 ft SAND: buff, fine- to medium-grained, slightly clayey to clayey.
18–20 ft SAND: buff, medium- to coarse-grained, clean; pebbly at base.
20–23 ft CLAY: ironstained, light grey, plastic.

BMP 1772 (Auger)

0– 5 ft LOAM: light grey and buff.
5–18 ft SAND: buff, fine- to medium-grained, clayey to very clayey; finer-grained and slightly silty below 12 ft.
18–21 ft SAND: buff to light grey, medium- to coarse-grained, clean.
21–23 ft CLAY: light grey-green, plastic, slightly sandy.

Remarks: Water (12 ft).

BMP 1773 (Auger)

0– 1 ft LOAM: light grey.
1–10 ft SAND: buff and light grey, medium-grained, very clayey; with very sandy CLAY.
10–15 ft CLAY: fawn to grey-green, sandy in part.
15–17 ft SAND: buff, medium-grained, clayey.
17–20 ft SAND: light grey and buff, medium-grained, clean.
20–23 ft SAND: light grey, medium-grained, clayey.
23–26 ft CLAY: grey to blue-grey.

Remarks: Water (15 ft).

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1774 (Auger)

0– 2 ft LOAM: light grey.
2–10 ft CLAY: light grey and brown, sandy.
10–14 ft SAND: light grey to buff, medium-grained, clayey.
14–20 ft SAND: mustard to buff, medium-grained, slightly clayey; few coarse-grained, clean, sand bands.
20–23 ft CLAY: very ironstained, grey.

Remarks: Water (10 ft).

BMP 1775 (Auger)

0–17 ft CLAY: brown and light grey, sandy.

BMP 1776 (Auger)

0– 2 ft LOAM: light grey.
2–17 ft CLAY: khaki to light brown, sandy, plastic.

BMP 1777 (Auger)

0– 4 ft LOAM: buff to brown, sandy.
4–14 ft CLAY: chocolate brown, plastic; sandy, 4–8 ft.
14–17 ft SAND: buff, coarse-grained, clean.
17–18 ft CLAY: light grey, plastic.
18–22 ft SAND: light grey, medium- to coarse-grained, slightly clayey.
22–23 ft CLAY: light grey, plastic.
23–25 ft SAND: grey, medium- to coarse-grained, slightly clayey.
25–27 ft CLAY: light grey, plastic.

BMP 1778 (Auger)

0– 2 ft LOAM: buff.
2– 5 ft CLAY: dark red-brown, plastic.
5–14 ft CLAY: red-brown to buff, sandy; with clayey SAND.
14–16 ft SAND: cream, fine- to medium-grained, clean.
16–21 ft SAND: buff, medium-grained, very clayey.
21–25 ft SAND: buff, medium- to coarse-grained, clayey to slightly clayey.
25–29 ft SAND: buff to light grey, coarse-grained, clean.
29–33 ft SAND: grey, medium- to coarse-grained, pebbly, slightly clayey.
33–35 ft CLAY: light grey, plastic.

BMP 1779 (Auger)

0– 5 ft LOAM: cream.
5– 8 ft SAND: light brown, very clayey.
8–16 ft CLAY: chocolate brown, plastic; sandy CLAY at base.
16–20 ft SAND: grey, coarse-grained, clayey. passing into light grey, pebbly, clean near base.
20–20+ ft CLAY.

BMP 1780 (Auger)

0– 2 ft CLAY: light grey, sandy (coarse-grained).
2–15 ft CLAY: light blue-grey, plastic.
15–18 ft SAND: light blue-grey, fine- to medium-grained, very clayey to clayey.
18–22 ft 6 in. SAND: light grey and buff, medium- to coarse-grained, clean.
22 ft 6 in.–24 ft SAND: light grey, coarse-grained, pebbly, clayey.
24–28 ft CLAY: light grey, plastic, slightly sandy.

Remarks: Water (15 ft).

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TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1781 (Auger)

0– 2 ft	SAND: buff, fine-grained, slightly clayey.
2– 8 ft	CLAY: ironstained, light grey and brown, plastic; thin SAND lens at 6 ft.
8–12 ft	SAND: light grey, very fine-grained, silty to clayey.
12–22 ft	SAND: buff, fine- to medium-grained, clayey.
22–25 ft	SAND: light grey to buff, fine- to medium-grained, slightly clayey.
25–28 ft	SAND: grey, very coarse-grained to pebbly, slightly clayey.
28–29 ft	CLAY: mustard to yellow, plastic.

Remarks: Water (8 ft).

BMP 1782 (Auger)

0– 5 ft	LOAM: light grey to buff.
5–10 ft	SAND: buff, fine-grained, slightly clayey.
10–14 ft	SAND: buff, medium-grained, slightly clayey.
14–19 ft	SAND: grey, medium-grained, very clayey.
19–21 ft	SAND: mustard, very fine-grained, very clayey.
21–24 ft	SAND: light grey, coarse-grained, clean.
24–27 ft	SAND: buff, medium- to coarse-grained, pebbly, slightly clayey.
27–27+ ft	GRAVEL and CLAY.

BMP 1783 (Auger)

0– 5 ft	SAND: buff to cream, slightly clayey.
5–18 ft	SAND: buff to light grey, medium-to coarse-grained, clean.
18–23 ft	SAND: blue-grey, coarse-grained, slightly clayey to clayey.
23–33 ft	SAND: grey, fine- to medium-grained, very clayey; with very sandy CLAY.
33–35 ft	CLAY: brown, plastic.

BMP 1784 (Auger)

0– 2 ft	LOAM: light grey.
2– 8 ft	CLAY: yellow to grey, sandy.
8–14 ft	SAND: buff, medium-grained, slightly clayey.
14–21 ft	SAND: buff, fine- to medium-grained, clayey to very clayey.
21–23 ft	SAND: light grey and buff, medium- to coarse-grained, clean.
23–25 ft	SAND: buff, medium-grained, very clayey.
25–26 ft	CLAY: light grey, plastic.

Remarks: Water (14 ft).

BMP 1785 (Auger)

0– 4 ft	CLAY: fawn to brown, sandy.
4– 9 ft	SAND: light grey to yellow-brown, fine-grained, slightly clayey to clayey.
9–14 ft	SAND: buff, very clayey; with sandy CLAY.
14–16 ft	CLAY: light grey, plastic.
16–18 ft	SAND: buff to cream, fine- to medium-grained, clean.
18–20 ft	CLAY: light grey, plastic.

BMP 1786 (Auger)

0–11 ft	CLAY: light grey to light chocolate brown, sandy.
11–19 ft	CLAY: buff, very sandy; with very clayey SAND bands.
19–20 ft	CLAY: light grey, plastic.

Remarks: Water (11 ft).

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1787 (Auger)

0– 8 ft	LOAM: light grey to buff.
8–11 ft	LOAM: yellow-brown, clayey.
11–19 ft	SAND: buff to yellow, medium- to coarse-grained, very clayey.
19–20 ft	CLAY: light grey, plastic.

Remarks: Water (11 ft).

BMP 1788 (Auger)

0– 9 ft	SAND: buff, medium- to coarse-grained, very clayey.
9–11 ft	CLAY: light grey, plastic.

BMP 1789 (Auger)

0– 6 ft	CLAY: light grey, sandy.
6–12 ft	LOAM: buff to yellow-brown; with fine-grained clayey SAND.
12–19 ft	SAND: buff to cream, medium- to coarse-grained, clayey; very sandy CLAY below 15 ft.
19–20 ft	CLAY: light grey, plastic.

Remarks: Water (12 ft).

BMP 1790 (Auger)

0– 2 ft	CLAY: fawn, plastic.
2– 8 ft	LOAM: light grey to fawn, sandy.
8–15 ft	SAND: red-brown and buff, clayey to very clayey.
15–18 ft	SAND: light grey, medium- to coarse-grained, clean.
18–20 ft	CLAY: light grey, plastic.

BMP 1791 (Auger)

0– 4 ft	LOAM: light grey to cream.
4– 8 ft	CLAY: light brown, sandy.
8–18 ft	SAND: light grey to cream, fine- to medium-grained, clean; slightly clayey, 8–11 ft.
18–20 ft	CLAY: light grey, plastic.

BMP 1792 (Auger)

0– 7 ft	LOAM: light grey to cream, sandy.
7–12 ft	SAND: buff, medium-grained, clean.
12–17 ft	CLAY: light grey, plastic.

BMP 1793 (Auger)

0– 3 ft	CLAY: red-brown, very sandy.
3– 6 ft	SAND: light grey to buff, medium-grained, clean.
6– 8 ft	SAND: buff, medium- to coarse-grained, very clayey.
8–10 ft	CLAY: light grey, plastic.
10–12 ft	SAND: cream, clean.
12–13 ft 6 in.	SAND: light grey, coarse-grained, very clayey.
13 ft 6in.–14 ft	CLAY: light grey, plastic.

BMP 1794 (Auger)

0– 6 ft	CLAY: grey to fawn, sandy.
6–11 ft	SAND: buff and yellow-brown, limonite-stained, clayey.
11–15 ft	SAND: buff to cream, medium- to coarse-grained, clean.
15–17 ft	SAND: light grey, coarse-grained, clayey to very clayey.
17–20 ft	CLAY: light grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1795 (Auger)
0–10 ft LOAM: light grey to buff; sandy below 8 ft.
10–12 ft SAND: buff, medium-grained, very clayey.
12–14 ft SAND: buff, fine- to medium-grained, clean.
14–19 ft SAND: buff, medium-grained, clayey to very clayey.
19–20 ft CLAY: light grey, plastic.

BMP 1796 (Auger)
0– 5 ft LOAM: light grey and buff.
5–13 ft SAND: buff to cream, very fine- to fine-grained, clayey to slightly clayey.
13–19 ft SAND: light grey, medium-grained, clayey and very clayey.
19–20 ft CLAY: light grey, plastic.
Remarks: Water (13 ft).

BMP 1797 (Auger)
0– 6 ft SAND: limonitic, brown, coarse-grained, with CLAY.
6– 8 ft CLAY: brown, plastic.
Remarks: Water (3 ft).

BMP 1798 (Auger)
0–12 ft SAND: buff, medium- to coarse-grained, very clayey; with very sandy CLAY.
12–14 ft CLAY: light grey, plastic.

BMP 1799 (Auger)
0–11 ft SAND: buff and light grey, medium- to coarse-grained, clayey and very clayey.
11–14 ft CLAY: light grey, plastic.

BMP 1800 (Auger)
0– 6 ft CLAY: brown and buff, very sandy.
6– 8 ft CLAY: light grey, plastic.

BMP 1801 (Auger)
0– 5 ft LOAM: grey, silty.
5– 8 ft SAND: light grey and buff, very clayey.
8–12 ft SAND: buff, medium- to coarse-grained, very clayey.
12–17 ft CLAY: light blue-grey, plastic.
Remarks: Water (8 ft).

BMP 1802 (Auger)
0– 5 ft LOAM: fawn to buff.
5–17 ft SAND: buff, clayey to very clayey.
17–24 ft CLAY: grey, slightly sandy; few thin clayey SAND bands.
24–26 ft CLAY: light grey to grey, plastic.
Remarks: Water (10 ft).

BMP 1803 (Auger)
0– 5 ft LOAM: light brown.
5–12 ft SAND: buff, fine-grained, clayey to very clayey.
12–33 ft SAND: buff, fine- to medium-grained; slightly clayey in part passing into grey, medium- to coarse-grained, clean, slightly clayey in part.
33–35 ft CLAY: light grey, plastic.
Remarks: Water (12 ft).

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1804 (Auger)
0–12 ft CLAY: light brown and grey, sandy, plastic.
12–23 ft SAND: grey to blue-grey, very fine- to coarse-grained, very clayey.
23–24 ft SAND: grey, medium-grained, slightly clayey.
24–29 ft SAND: dark grey, medium-grained, very clayey; with sandy CLAY bands.
Remarks: Water (12 ft).

BMP 1805 (Auger)
0– 2 ft CLAY: yellow-brown, sandy.
2–12 ft SAND: buff to fawn, fine- to medium-grained, clean.
12–18 ft SAND: grey, fine- to medium-grained, slightly clayey; numerous clay pellets.
18–21 ft SAND: light grey, medium- to coarse-grained, clean.
21–23 ft CLAY: light grey and fawn, plastic.
Remarks: Water (9 ft).

BMP 1806 (Auger)
0– 9 ft CLAY: brown, sandy; with abundant carbonaceous material.
9–14 ft SAND: grey, fine- to medium-grained, very clayey.
14–15 ft SAND: grey, coarse-grained, clean.
15–17 ft SAND: grey, coarse-grained, very clayey.
17–20 ft CLAY: grey, sandy, plastic.
Remarks: Water (7 ft).

BMP 1807 (Auger)
0– 8 ft LOAM: buff to fawn.
8–14 ft CLAY: ironstained, light grey, slightly sandy, plastic.
14–17 ft SAND: buff, fine-grained, clayey to very clayey.
17–21 ft SAND: buff, fine-grained, slightly silty.
21–23 ft CLAY: yellow and fawn, plastic.

BMP 1808 (Auger)
0– 8 ft CLAY: red-brown and grey, sandy.
8–12 ft CLAY: blue-grey, plastic.

BMP 1809 (Auger)
0– 8 ft SAND: buff, fine- to medium-grained, clean,
8–12 ft SAND: light grey, medium-grained.
12–20 ft SAND: blue-grey, coarse-grained, very clayey; with sandy CLAY; pebbly below 19 ft.

BMP 1810 (Auger)
0– 8 ft LOAM: buff, sandy.
8–17 ft SAND: buff, medium-grained, clean. passing into grey, medium-grained, clean.
17–19 ft CLAY: grey-green, very sandy; with clayey SAND.
19–21 ft SAND: buff, medium- to coarse-grained, clean.
21–26 ft SAND: light grey, medium- to coarse-grained, slightly clayey.
26–26+ ft CLAY: grey, plastic.

BMP 1811 (Auger)
0– 5 ft LOAM: light grey; with grey sandy clay nodules.
5– 9 ft SAND: white and cream, very fine-grained, silty.
9–12 ft SAND: buff, medium-grained, slightly clayey.
12–17 ft SAND: buff and light grey, very clayey; with sandy CLAY.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

4. Portion 283, Parish of Oxley (Oxley Creek)—continued

BMP 1812 (Auger)

0– 5 ft LOAM: light grey to fawn.
5– 9 ft SAND: pink to cream, very fine-grained; with sandy LOAM.
9–17 ft SAND: grey to dark grey, clayey to very clayey passing into
CLAY: sandy.
17–20 ft CLAY: grey, plastic.

BMP 1813 (Auger)

0– 4 ft LOAM: light grey to fawn.
4– 6 ft CLAY: fawn, plastic.
6–12 ft LOAM: cream to white; with fine-grained SAND.
12–16 ft SAND: buff, clayey to very clayey.
16–20 ft CLAY: light grey, sandy; plastic below 19 ft.

BMP 1896 (Bailer)

0– 5 ft LOAM: buff.
5– 9 ft 9 in. SAND: buff to cream, fine-grained, very clayey.
9 ft 9 in.–13 ft 10 in. SAND: buff, fine-grained, very clayey.
13 ft 10 in.–16 ft 5 in. SAND: light grey, fine- to medium-grained, slightly clayey to clayey; with abundant charcoal fragments.
16 ft 5 in.–18 ft 2 in. SAND: grey, fine- to medium-grained, clayey; with large clay pellets and abundant charcoal fragments.
18 ft 2 in.–20 ft 1 in. SAND: grey, fine- to medium-grained, clayey; with abundant charcoal fragments.
20 ft 1 in.–23 ft 1 in. SAND: grey, medium-grained, clean to slightly clayey; wood fragments.
23 ft 1 in.–24 ft 6½ in. SAND: grey, coarse-grained, clean; pebbly, with few clay pellets at base.
24 ft 6½ in.–25 ft 3 in. SAND: dark grey, pebbly, very clayey.

BMP 1897 (Bailer)

0– 5 ft LOAM: buff.
5– 8 ft 4 in. LOAM: cream; fine-grained SAND interbedded.
8 ft 4 in.–10 ft 5 in. SAND: buff, fine- to medium-grained, clayey.
10 ft 5 in.–11 ft 4½ in. SAND: buff, fine- to medium-grained, slightly clayey.
11 ft 4½ in.–12 ft 4½ in. SAND: buff, medium-grained, slightly clayey; with thin CLAY bands.
12 ft 4½ in.–15 ft 9½ in. SAND: buff, fine-grained, very clayey; with sandy clay pellets.
15 ft 9½ in.–16 ft 11½ in. SAND: buff to grey, fine- to medium-grained, clayey.
16 ft 11½ in.–18 ft 7 in. SAND: light grey, medium-grained, clayey.

5. Portions 284 and 286, Parish of Oxley (Oxley Creek)

Logs by: B. A. Coxhead.

BMP 1814 (Auger)

0– 6 ft LOAM: light grey.
6–16 ft SAND: light grey and cream, fine- to medium-grained, clean; slightly clayey at top.
16–17 ft CLAY: grey-green, plastic.

BMP 1815 (Auger)

0–11 ft CLAY: grey and fawn, sandy.
11–13 ft SAND: cream, medium- to fine-grained, slightly clayey.
13–18 ft SAND: grey, coarse-grained, clean.
18–20 ft SAND: grey, coarse-grained, slightly clayey.
20–23 ft CLAY: light grey, sandy.
Remarks: Water (11 ft).

BMP 1816 (Auger)

0– 2 ft LOAM: light grey.
2– 5 ft CLAY: grey-green; with grey LOAM bands.
5– 8 ft LOAM: cream, sandy.
8–14 ft SAND: cream and light grey, fine- to medium-grained, clean.
14–15 ft SAND: light grey, slightly clayey to clayey.
15–17 ft CLAY: light grey, sandy.

BMP 1817 (Auger)

0– 8 ft LOAM: light grey to buff.
8–17 ft CLAY: red-brown to fawn, sandy, with 6 in. cream SAND band at 15 ft.

BMP 1818 (Auger)

0– 5 ft LOAM.
5–12 ft SAND: cream, fine-grained passing into red-brown, medium-grained, clayey.
12–14 ft CLAY: ironstained, grey, plastic.

BMP 1819 (Auger)

0– 5 ft LOAM.
5–16 ft SAND: cream to buff, fine- to medium-grained, clean; slightly clayey at base.
16–18 ft SAND: grey, very clayey; with sandy CLAY.
18–25 ft SAND: grey, coarse-grained, clean.
25–26 ft CLAY: grey, sandy.

BMP 1820 (Auger)

0– 5 ft LOAM: buff, slightly sandy.
5–25 ft SAND: buff to cream, medium-grained, clean passing into light grey and cream, coarse-grained, clean.
25–26 ft CLAY: grey-green, plastic.

BMP 1821 (Auger)

0– 8 ft LOAM: light grey and buff.
8–14 ft SAND: cream, fine-grained, slightly clayey.
14–15 ft SAND: buff, fine-grained, clayey.
15–20 ft SAND: buff, fine-grained, slightly clayey; clayey below 18 ft.
20–23 ft CLAY: light grey and fawn, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1822 (Auger)

0– 2 ft LOAM: light grey.
2– 6 ft CLAY: light grey and buff, sandy.
6–14 ft SAND: cream, fine-grained, slightly clayey to clayey.
14–17 ft CLAY: grey, very sandy.

BMP 1823 (Auger)

0– 1 ft LOAM: light grey.
1– 2 ft CLAY: light grey.
2– 6 ft SAND: buff, fine- to medium-grained, slightly clayey.
6– 8 ft SAND: grey, fine- to medium-grained, clean.
8–12 ft SAND: grey, medium-grained, clayey.
12–17 ft SAND: grey to buff, medium-grained, very clayey.
17–20 ft CLAY: grey, sandy.

BMP 1824 (Auger)

0– 2 ft LOAM: light grey.
2– 8 ft LOAM: buff to fawn; bands of CLAY.
8–11 ft SAND: cream to light grey, fine-grained, clean.
11–16 ft SAND: light grey, fine- to medium-grained, clayey to very clayey.
16–17 ft CLAY: red-brown, hard.

BMP 1825 (Auger)

0– 9 ft LOAM: grey to fawn.
9–14 ft CLAY: grey-green, plastic.

BMP 1826 (Auger)

0– 8 ft LOAM: light grey.
8–11 ft SAND: buff, medium-grained, slightly clayey.
11–15 ft SAND: grey, medium- to coarse-grained, clayey.
15–24 ft SAND: grey, very clayey; with sandy CLAY.
24–26 ft CLAY: light grey, plastic.

BMP 1827 (Auger)

0– 5 ft LOAM: light grey to buff.
5–11 ft SAND: light grey, fine-grained, slightly clayey; a few thin clayey SAND bands.
11–17 ft SAND: light grey, medium-grained, clean; clayey in bottom 6 in.
17–20 ft CLAY: light grey to grey, plastic.
Remarks: Water (11 ft).

BMP 1828 (Auger)

0– 8 ft LOAM: light grey.
8–14 ft SAND: light grey, fine-grained, very clayey; with sandy CLAY.
14–20 ft CLAY: light grey and brown, plastic.

BMP 1829 (Auger)

0– 1 ft LOAM: light grey.
1–12 ft CLAY: light grey; with grey-green CLAY.
12–21 ft SAND: grey, medium-grained, clean; clayey in top 6 in.; coarse-grained below 16 ft.
21–23 ft SAND: coarse-grained; with light grey CLAY.
23–26 ft CLAY: light grey, ironstained.
Remarks: Water (12 ft).

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1830 (Auger)

0– 5 ft LOAM: light grey.
5–12 ft SAND: buff to cream, fine- to medium-grained, clean; coarse-grained below 10 ft.
12–14 ft CLAY: light grey, sandy.

BMP 1831 (Auger)

0– 2 ft LOAM: light grey to fawn.
2–17 ft CLAY: light grey and ironstained brown, plastic.

BMP 1832 (Auger)

0– 5 ft LOAM: light grey.
5–15 ft CLAY: brown, sandy, plastic.
15–17 ft CLAY: light grey, soapy.

BMP 1833 (Auger)

0–14 ft LOAM: light grey to fawn and buff.
14–29 ft SAND: buff, medium-grained, clayey passing into light grey, very clayey.
29–32 ft CLAY: light grey, plastic.

BMP 1834 (Auger)

0– 1 ft LOAM: light grey.
1– 9 ft CLAY: cream to light grey-green, sandy.
9–16 ft SAND: cream, fine- to medium-grained, clean.
16–20 ft SAND: light grey, fine- to medium-grained clayey to very clayey.
Remarks: Water (9 ft).

BMP 1835 (Auger)

0– 1 ft LOAM: light grey.
1– 4 ft CLAY: fawn, plastic.
4–15 ft SAND: cream, fine- to medium-grained, clean; coarse-grained below 9 ft.
15–17 ft CLAY.
Remarks: Water (6 ft).

BMP 1836 (Auger)

0– 3 ft LOAM: light grey.
3–17 ft CLAY: light grey and fawn, plastic.

BMP 1837 (Auger)

0– 4 ft LOAM: buff.
4–17 ft CLAY: light grey, fawn and red-brown, plastic.

BMP 1838 (Auger)

0– 2 ft LOAM: light grey.
2–11 ft CLAY: light grey and fawn, plastic.
11–13 ft SAND: buff, medium-grained, clayey to very clayey.
13–14 ft CLAY: buff, sandy.
Remarks: Water (11 ft).

BMP 1839 (Auger)

0– 5 ft LOAM: light grey and cream.
5–17 ft SAND: buff, very clayey; with sandy CLAY.
17–24 ft SAND: light grey, clayey.
24–26 ft CLAY: light grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1840 (Auger)
0– 3 ft LOAM: buff.
3–20 ft CLAY: light grey and fawn, slightly sandy; ironstained below 15 ft.

BMP 1841 (Auger)
0– 7 ft LOAM: light grey to white, sandy.
7–16 ft CLAY: buff, sandy.
16–17 ft SAND: buff, clayey.
17–23 ft CLAY: buff, sandy passing into light grey, plastic.

BMP 1842 (Auger)
0– 5 ft LOAM: light grey to buff.
5–11 ft CLAY: fawn and buff, sandy.
11–14 ft SAND: light grey to cream, fine-grained, slightly clayey.
14–18 ft SAND: grey to fawn, medium-grained, clayey; very clayey at base.
18–20 ft CLAY: fawn, plastic.

BMP 1843 (Auger)
0– 5 ft LOAM: light grey, sandy.
5–15 ft CLAY: light grey and buff, sandy; few thin very clayey SAND bands.
15–17 ft CLAY: light grey, ironstained, plastic.

BMP 1844 (Auger)
0– 5 ft LOAM: light grey, very sandy.
5–17 ft CLAY: fawn to grey, plastic.

BMP 1845 (Auger)
0– 6 ft LOAM: light grey.
6–17 ft CLAY: light grey, plastic; bottom 3 ft ironstained.

BMP 1846 (Auger)
0– 5 ft LOAM: light grey, sandy.
5–17 ft CLAY: grey to brown, plastic; top 3 ft sandy.

BMP 1847 (Auger)
0– 5 ft LOAM: light grey, sandy.
5–14 ft CLAY: grey and brown, sandy in part.

BMP 1848 (Auger)
0– 5 ft LOAM: light grey to buff.
5–17 ft CLAY: fawn to light grey, plastic.

BMP 1849 (Auger)
0– 3 ft LOAM: light grey.
3–17 ft SAND: fawn to yellow-brown; very clayey and clayey.
17–21 ft SAND: cream, fine- to medium-grained, slightly clayey.
21–23 ft CLAY: yellow-brown, slightly sandy.

BMP 1850 (Auger)
0–10 ft LOAM: fawn to buff.
10–13 ft SAND: light grey, fine-grained, clayey to very clayey.
13–18 ft SAND: buff, medium- to coarse-grained, clean.
18–21 ft CLAY: light grey, sandy.
21–23 ft CLAY: dark grey to black, sandy, puggy.

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1851 (Auger)
0– 2 ft LOAM: light grey.
2–14 ft CLAY: fawn to light grey, plastic; top 2 ft slightly sandy.

BMP 1852 (Auger)
0– 4 ft LOAM: light grey.
4–11 ft CLAY: fawn to yellow-brown, sandy.
11–14 ft SAND: coarse-grained; with CLAY.
14–17 ft SAND: cream, fine- to medium-grained, slightly clayey.
17–21 ft SAND: medium- to coarse-grained, clayey.
21–23 ft CLAY: grey, very sandy.

BMP 1853/54 (Auger)
0–11 ft LOAM: light grey to cream; sandy below 5 ft.
11–16 ft CLAY: fawn, sandy.
16–19 ft SAND: buff to fawn, fine-grained, clayey.
19–21 ft SAND: light grey, medium-grained, slightly clayey.
21–27 ft SAND: light grey, medium- to coarse-grained, clayey; pebbly, 23–25 ft.
27–29 ft CLAY: grey-green, puggy.

BMP 1855 (Auger)
0– 5 ft LOAM: light grey.
5–11 ft CLAY: fawn and yellow-brown, sandy; with very clayey SAND.
11–13 ft SAND: cream, fine-grained, slightly clayey.
13–16 ft SAND: light grey, medium- to coarse-grained, clean.
16–19 ft SAND: light grey, coarse-grained, clayey.
19–23 ft CLAY: light grey, sandy passing into light grey, plastic.

BMP 1856 (Auger)
0– 8 ft LOAM: light grey to cream.
8–11 ft SAND: cream, medium-grained, slightly clayey.
11–18 ft SAND: cream, fine- to medium-grained, clean.
18–20 ft CLAY: light grey, sandy.

BMP 1857 (Auger)
0–10 ft LOAM: light grey and buff; sandy, 8–10 ft.
10–15 ft SAND: buff, fine-grained, slightly clayey.
15–21 ft SAND: light grey, slightly clayey.
21–23 ft CLAY: light grey, plastic.
Remarks: Water (10 ft).

BMP 1858 (Auger)
0– 5 ft LOAM: light grey to cream.
5– 9 ft SAND: cream, fine-grained, clean.
9–10 ft SAND: light grey, clayey; with clay blebs.
10–12 ft SAND: light grey, medium-grained, clean.
12–14 ft SAND: light grey, clayey to very clayey.
14–17 ft CLAY: light grey, plastic.
Remarks: Water (10 ft).

BMP 1859 (Auger)
0– 5 ft LOAM.
5– 8 ft SANDSTONE: cream, medium-grained, decomposed.
8–14 ft CLAY: light grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1860 (Auger)

0– 5 ft LOAM: cream to buff.
5–11 ft CLAY: buff, sandy.
11–14 ft CLAY: grey, plastic.

BMP 1861 (Auger)

0– 8 ft LOAM: light grey to cream; sandy towards base.
8–12 ft SAND: buff, fine- to medium-grained, slightly clayey to clayey.
12–18 ft SAND: light grey, fine- to medium-grained, slightly clayey in part.
18–21 ft SAND: grey-green, clayey to very clayey.
21–35 ft SAND: cream and light grey, medium-grained, clean.

BMP 1862 (Auger)

0– 3 ft LOAM: light grey.
3–10 ft CLAY: buff to yellow-brown, very sandy.
10–17 ft SAND: buff, fine-grained, very clayey; with sandy CLAY bands.
17–20 ft CLAY: light grey, plastic.

Remarks: Water (10 ft).

BMP 1863 (Auger)

0– 8 ft LOAM: fawn to cream.
8–12 ft SAND: cream, fine-grained, clayey.
12–17 ft SAND: cream, fine-grained, slightly clayey.
17–20 ft SAND: light grey, medium-grained, clayey to very clayey.
20–23 ft CLAY: light grey, plastic.

BMP 1864 (Auger)

0– 2 ft LOAM: light grey.
2–10 ft CLAY: buff to grey, sandy.
10–14 ft SAND: light grey, clayey to very clayey.
14–17 ft CLAY: light grey, sandy.

Remarks: Water (10 ft).

BMP 1865 (Auger)

0– 2 ft LOAM
2– 6 ft SAND: cream, clayey.
6–10 ft SAND: cream, fine- to medium-grained, slightly clayey.
10–12 ft SAND: cream, clayey.
12–16 ft CLAY: buff, sandy.
16–18 ft SAND: light grey, fine- to medium-grained, clean.
18–20 ft CLAY: blue-grey, sandy.

Remarks: Water (9 ft).

BMP 1866 (Auger)

0– 3 ft LOAM: light grey.
3– 8 ft SAND: cream and yellow, clayey to very clayey.
8–13 ft SAND: cream, medium-grained, slightly clayey to clayey.
13–16 ft SAND: buff to cream, very clayey.
16–18 ft CLAY: buff, sandy.
18–21 ft SAND: light grey, medium-grained, slightly clayey.
21–23 ft CLAY: light grey, plastic.

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1867 (Auger)

0– 4 ft LOAM: light grey.
4– 8 ft CLAY: buff to light grey, sandy.
8–11 ft SAND: light grey, very clayey.
11–18 ft SAND: light grey, fine- to medium-grained, slightly clayey to clayey.
18–19 ft GRAVEL: light grey.
19–21 ft CLAY: light grey, plastic.

Remarks: Water (11 ft).

BMP 1868 (Auger)

0– 5 ft LOAM: light grey to fawn.
5–11 ft CLAY: buff, sandy.
11–13 ft SAND: buff, fine-grained, clayey.
13–17 ft SAND: light grey, coarse.
17–20 ft SAND: grey, coarse-grained; with light grey CLAY.
20–23 ft CLAY: light grey, plastic.

Remarks: Water (11 ft).

BMP 1869 (Auger)

0– 2 ft LOAM: fawn.
2–15 ft SAND: cream, fine-grained, clean passing into light grey, fine-grained, slightly clayey.
15–18 ft SAND: grey, medium-grained, slightly clayey.
18–22 ft CLAY: grey; with medium- to coarse-grained SAND.
22–26 ft CLAY: blue-grey, sandy.

BMP 1870 (Auger)

0– 5 ft LOAM: buff.
5–16 ft SAND: light grey and cream, medium- to coarse-grained, clean.
16–18 ft SAND: grey, coarse-grained, slightly clayey.
18–20 ft CLAY: grey; with coarse-grained SAND.
20–23 ft CLAY: grey-green, plastic.

BMP 1871 (Auger)

0– 9 ft CLAY: dark grey, plastic.
9–11 ft CLAY: light grey, plastic.
11–15 ft SAND: light grey, fine-grained, clayey.
15–18 ft SAND: light grey to cream, medium-grained, clean.
18–20 ft CLAY: light grey, plastic.

Remarks: Water (11 ft).

BMP 1872 (Auger)

0– 5 ft LOAM: light grey.
5–17 ft CLAY: light grey and buff, sandy; a few thin very clayey SAND bands.

BMP 1873 (Auger)

0– 4 ft LOAM: light grey to fawn.
4–11 ft CLAY: yellow-brown, plastic passing into blue-grey, sandy.
11–14 ft SAND: buff, fine- to medium-grained, very clayey.
14–16 ft SAND: light grey, fine- to medium-grained, slightly clayey.
16–20 ft SAND: light grey, fine- to medium-grained, clayey to very clayey.
20–23 ft CLAY: light grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1874 (Auger)

0– 2 ft LOAM: light grey.
2– 5 ft CLAY: fawn, sandy.
5– 8 ft SAND: buff, medium-grained, slightly clayey to clayey.
8–18 ft SAND: light grey, fine- to medium-grained, clayey to very clayey.
18–20 ft CLAY: blue-grey, sandy.

Remarks: Water (5 ft).

BMP 1875 (Auger)

0– 5 ft LOAM: light grey to buff.
5– 7 ft SAND: yellow-brown, clayey.
7–12 ft SAND: buff, fine- to medium-grained, slightly clayey.
12–16 ft SAND: light grey, medium-grained, clean.
16–21 ft SAND: light grey, medium-grained, clayey.
21–23 ft CLAY: light grey, sandy.

BMP 1876 (Auger)

0– 3 ft LOAM: fawn.
3–11 ft CLAY: fawn to yellow-brown, sandy.
11–14 ft SAND: buff, fine-grained, clayey.
14–17 ft SAND: light grey, fine- to medium-grained, slightly clayey.
17–21 ft SAND: light grey, clayey to very clayey.
21–23 ft CLAY: light grey, plastic.

BMP 1877 (Auger)

0– 5 ft LOAM: fawn.
5–11 ft CLAY: fawn, sandy.
11–15 ft SAND: cream to light grey, fine-grained, clayey.
15–19 ft SAND: light grey, fine-grained, slightly clayey; clayey near base.
19–20 ft CLAY: light grey, plastic.

BMP 1878 (Auger)

0– 3 ft LOAM: light grey.
3– 8 ft CLAY: yellow-brown, sandy.
8–15 ft SAND: light grey, fine-grained, clayey.
15–18 ft SAND: light grey, medium-grained, clean.
18–20 ft CLAY: light grey, plastic.

BMP 1879 (Auger)

0– 5 ft LOAM: fawn.
5– 8 ft CLAY: buff, sandy.
8–11 ft SAND: light grey, medium-grained, clayey.
11–20 ft SAND: light grey, medium-grained, clean.
20–22 ft SAND: light grey, clayey.
22–23 ft CLAY: light grey, plastic.

BMP 1880 (Auger)

0– 5 ft LOAM: fawn.
5–11 ft SAND: yellow-brown, limonite-stained, clayey.
11–13 ft SAND: cream, fine-grained, slightly clayey to clayey.
13–16 ft SAND: light grey, fine- to medium-grained, clean.
16–20 ft SAND: light grey, medium-grained, very clayey.
20–23 ft CLAY: light grey, plastic.

Remarks: Water (11 ft).

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1881 (Auger)

0– 4 ft LOAM: light grey.
4– 8 ft CLAY: fawn, sandy.
8–12 ft SAND: cream, fine-grained, clean.
12–17 ft CLAY: fawn to light grey, sandy, plastic.

BMP 1882 (Auger)

0– 3 ft LOAM: fawn.
3–11 ft CLAY: fawn to light grey, plastic.
11–14 ft LOAM: light grey and cream, slightly sandy.
14–17 ft SAND: buff, medium-grained, very clayey.
17–20 ft CLAY: fawn, sandy.

BMP 1883 (Auger)

0– 3 ft LOAM: buff.
3– 8 ft CLAY: buff to light grey, sandy.
8–17 ft CLAY: fawn, plastic.

BMP 1884 (Auger)

0– 8 ft LOAM: buff to light brown.
8–17 ft CLAY: brown to light grey, plastic; top 3 ft sandy.

BMP 1885 (Auger)

0– 4 ft LOAM: light grey.
4– 8 ft CLAY: fawn and light brown, very sandy.
8–14 ft CLAY: light grey, plastic.
14–23 ft SAND: buff to brown, very clayey, with sandy CLAY.

BMP 1886 (Auger)

0– 3 ft LOAM.
3– 8 ft SAND and CLAY.
8–20 ft CLAY: grey, plastic.

BMP 1887 (Auger)

0– 5 ft LOAM: buff.
5–12 ft SAND: cream, fine-grained, slightly clayey; clayey below 10 ft.
12–18 ft CLAY: light grey, sandy.

BMP 1888 (Auger)

0– 5 ft LOAM: light grey to fawn.
5– 8 ft CLAY: brown, sandy.
8–11 ft SAND: cream, fine-grained, clayey.
11–14 ft SAND: cream, fine- to medium-grained, clean.
14–18 ft SAND: light grey, medium-grained, clayey to very clayey.
18–20 ft CLAY: light grey, plastic.

BMP 1889 (Auger)

0– 5 ft LOAM: fawn and yellow-brown.
5– 9 ft SAND: buff, medium-grained, very clayey.
9–12 ft SAND: cream, fine- to medium-grained, clean.
12–15 ft SAND: grey, medium-grained, very clayey; with sandy CLAY.
15–17 ft CLAY: light grey, sandy.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

BMP 1890 (Bailer)

0– 7 ft 7½ in.	LOAM: fawn to buff.
7 ft 7½ in.–11 ft 3½ in.	SAND: buff to cream, fine-grained, clayey.
11 ft 3½ in.–12 ft 8½ in.	SAND: cream, fine- to medium-grained, clean to slightly clayey.
12 ft 8½ in.–13 ft 9 in.	SAND: cream, medium-grained, slightly clayey.
13 ft 9 in.–15 ft 6 in.	SAND: light grey to cream, medium-grained, clayey to slightly clayey.
15 ft 6 in.–18 ft 1 in.	SAND: light grey to cream and white, medium- to coarse-grained, clean.
18 ft 1 in.–18 ft 8 in.	SAND: light grey, medium- to coarse-grained, slightly clayey.
18 ft 8 in.–20 ft 3 in.	SAND: light grey, coarse-grained, clean.
20 ft 3 in.–21 ft 3½ in.	SAND: grey, medium- to coarse-grained, clayey; few small clay pellets.
21 ft 3½ in.–22 ft 4 in.	SAND: grey, medium- to coarse-grained, clayey.
22 ft 4 in.–23 ft 11 in.	CLAY: buff and grey, plastic.

BMP 1891 (Bailer)

0– 7 ft 8½ in.	LOAM: buff, sandy.
7 ft 8½ in.– 9 ft 3 in.	SAND: buff, fine-grained, clayey.
9 ft 3 in.–10 ft 4½ in.	SAND: cream, fine- to medium-grained, slightly clayey; few light grey clay pellets.
10 ft 4½ in.–14 ft 1 in.	SAND: cream, medium-grained, clean.
14 ft 1 in.–14 ft 7 in.	SAND: cream, coarse-grained, clean; with ½ in. grey CLAY band and few large white quartz pebbles.
14 ft 7 in.–22 ft 8½ in.	SAND: cream, coarse-grained, clean; few yellow clay pellets from base included in sample.

BMP 1892 (Bailer)

0– 5 ft 10½ in.	LOAM: light grey; very sandy at base.
5 ft 10½ in.– 6 ft 8½ in.	SAND: cream, fine-grained, clean.
6 ft 8½ in.– 7 ft 7½ in.	SAND: cream, fine-grained, slightly clayey.
7 ft 7½ in.– 8 ft 1½ in.	SAND: cream, fine- to medium-grained, clean.
8 ft 1½ in.– 9 ft 2½ in.	SAND: cream, fine-grained, slightly clayey.
9 ft 2½ in.–10 ft 1½ in.	SAND: cream, fine- to medium-grained, slightly clayey; few ¼ in. pebbles and clay pellets.
10 ft 1½ in.–10 ft 8½ in.	SAND: cream to light grey, medium-grained, clean.
10 ft 8½ in.–11 ft 3½ in.	SAND: cream, medium- to coarse-grained, clean.
11 ft 3½ in.–14 ft 2½ in.	SAND: cream, medium-grained, clean; few large pebbles below 12 ft 7½ in.
14 ft 2½ in.–15 ft 6½ in.	SAND: light grey, medium- to coarse-grained, slightly clayey.

5. Portions 284 and 286, Parish of Oxley (Oxley Creek) —continued

15 ft 6½ in.–16 ft 3 in.	SAND: light grey, coarse-grained, clean.
16 ft 3 in.–18 ft 0½ in.	SAND: light grey, coarse-grained, pebbly; few clay pellets.
18 ft 0½ in.–18 ft 4½ in.	SAND: grey, pebbly; with CLAY.

BMP 1893 (Auger)

0– 2 ft	LOAM: grey to light grey.
2– 8 ft	CLAY: buff to fawn, plastic.
8–14 ft	SAND: cream, fine-grained, very clayey.
14–18 ft	SAND: light grey, fine- to medium-grained, clayey.
18–21 ft	SAND: brown, very coarse-grained; with CLAY.
21–26 ft	SAND: buff, medium-grained, very clayey; with sandy CLAY.

BMP 1894 (Auger)

0– 2 ft	LOAM: grey.
2– 5 ft	SAND: cream, fine-grained.
5–10 ft	SAND: buff to yellow-brown, fine-grained, very clayey.
10–14 ft	SAND: cream, fine-grained, slightly clayey.
14–17 ft	SAND: cream, medium-grained, clean.
17–23 ft	SAND: light grey, medium-grained, clayey to very clayey.
23–26 ft	CLAY: brown, sandy (very coarse-grained).

BMP 1895 (Auger)

0– 2 ft	LOAM: grey.
2– 5 ft	SAND: cream, fine-grained, clean.
5–14 ft	SAND: buff to yellow-brown, medium-grained, slightly clayey to clayey.
14–17 ft	SAND: cream, fine- to medium-grained, clean.
17–20 ft	SAND: light grey, clayey to very clayey.
20–23 ft	CLAY: brown, sandy (very coarse-grained).

BMP 1907 (Auger)

0– 3 ft	LOAM: light grey.
3– 5 ft	SAND: cream, fine-grained, clean.
5–10 ft	CLAY: buff, very sandy.
10–14 ft	SAND: cream to light grey, medium-grained, clayey.
14–20 ft	SAND: light grey, medium-grained, very clayey.
20–23 ft	CLAY: light grey, plastic.

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6. Portions 285 and 290, Parish of Oxley (Oxley Creek)

Logs by: J. D. Sawers

BMP 1317 (Auger)

0– 2 ft	SOIL: grey-brown.
2– 5 ft	CLAY: brown, silty.
5–14 ft	SILTSTONE: light grey.
14–17 ft	CLAY: light brown to yellow, sandy; grey SANDSTONE bands.

BMP 1318 (Auger)

0– 2 ft	SOIL.
2– 5 ft	CLAY: brown, sandy.
5–11 ft	SANDSTONE: grey to light brown, clayey; silty near base.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1319 (Auger)

0– 2 ft SOIL: light brown.
2– 8 ft CLAY: brown, silty.
8–11 ft CLAY: grey-brown, sandy, plastic.
11–14 ft CLAY: brown-grey, plastic.

BMP 1320 (Auger)

0– 2 ft SOIL: brown.
2– 8 ft CLAY: brown, silty.
8–11 ft CLAY: grey-brown, plastic.

BMP 1321 (Auger)

0– 2 ft SOIL: grey-brown.
2– 9 ft CLAY: brown to grey, silty, plastic.
9–11 ft CLAY: terra cotta to grey, plastic.

BMP 1322 (Auger)

0– 2 ft LOAM: light brown.
2– 5 ft CLAY: light brown, silty.
5– 8 ft CLAY: brown, semi-plastic.
8–11 ft CLAY: brown, plastic.

BMP 1323 (Auger)

0– 2 ft SOIL: buff, silty.
2–11 ft CLAY: brown, silty.
11–14 ft CLAY: brown, semi-plastic.

BMP 1324 (Auger)

0– 1 ft SOIL.
1– 5 ft LOAM: buff, sandy.
5–10 ft LOAM: thin decomposed SANDSTONE bands.
10–11 ft CLAY: grey-brown, semi-plastic.

BMP 1325 (Auger)

0– 2 ft LOAM: brown to buff, clayey.
2– 5 ft CLAY: grey-brown, sandy.
5–10 ft CLAY: brown, plastic.
10–12 ft SAND: grey, clayey.
12–14 ft SANDSTONE: brown, decomposed; quartz pebbles.

BMP 1326 (Auger)

0– 2 ft SOIL: grey to brown, sandy.
2–11 ft LOAM: buff, sandy.
11–14 ft SAND: coarse-grained, brown, clayey.
14–17 ft CLAY: brown, plastic.

BMP 1327 (Auger)

0– 2 ft SOIL.
2– 5 ft CLAY: light brown, sandy.
5– 8 ft CLAY: brown, sandy; decomposed SANDSTONE bands.
8–11 ft CLAY: brown, sandy.
11–13 ft SANDSTONE: brown, decomposed, argillaceous.
13–14 ft CLAY: grey-brown, semi-plastic.

BMP 1328 (Auger)

0– 2 ft SOIL: brown, silty.
2– 5 ft CLAY: brown, semi-plastic.
5–11 ft CLAY: brown, plastic.
11–14 ft CLAY: grey-brown, sandy.
Remarks: Water (14 ft).

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1329 (Auger)

0– 5 ft SOIL: medium brown, silty.
5–10 ft CLAY: medium brown, plastic.
10–16 ft LOAM: yellow-brown.
16–37 ft SAND: fine-grained, pebbly, medium grey; with thin CLAY bands from about 26 ft.
37–38 ft CLAY: medium grey, plastic.
Remarks: Water (14 ft).

BMP 1330 (Auger)

0–17 ft LOAM: very sandy (very fine- to medium-grained), buff to yellow.
17–28 ft 8 in. SAND: medium- to coarse-grained, grey; 2 ft silty CLAY band at 22 ft.
28 ft 8 in.–29 ft CLAY: pebbly and silty.
Remarks: Water (17 ft).

BMP 1331 (Auger)

0– 5 ft SOIL: buff, silty.
5–11 ft CLAY: medium brown, semi-plastic to plastic; laminated.
11–20 ft LOAM: slightly clayey; yellow.
20–23 ft SAND: medium- to coarse-grained, grey.
23–29 ft CLAY: grey-green, plastic.

BMP 1332 (Auger)

0– 5 ft LOAM: buff.
5– 8 ft SAND: very fine- to fine-grained, buff.
8–12 ft SAND: fine- to medium-grained, grey.
12–29 ft SILTY CLAY: blue-black; with rare pebbles.

BMP 1333 (Auger)

0– 7 ft LOAM: buff, fine-grained.
7–10 ft SAND: grey, fine- to medium-grained, clayey.
10–18 ft SILTY CLAY: dark grey-brown.
18–25 ft SAND: fine- to medium-grained, grey.
25–26 ft SAND: coarse-grained, pebbly.
Remarks: Water (18 ft).

BMP 1334 (Auger)

0– 2 ft SOIL: buff, fine-grained.
2– 5 ft CLAY: brown.
5– 8 ft LOAM: buff, sandy.
8–17 ft SILTY CLAY: brown-grey to grey.

BMP 1335 (Auger)

0–10 ft LOAM: buff, fine-grained.
10–15 ft SILTY CLAY: grey-brown.
15–28 ft SAND: grey, fine- to medium-grained.
28–29 ft GRAVEL: sandstone pebbles.

BMP 1336 (Auger)

0– 5 ft LOAM: buff, fine-grained.
5–11 ft LOAM: brown, fine- to medium-grained.
11–14 ft LOAM: yellow-brown, coarse-grained.
14–18 ft SAND: yellow, fine-grained, clayey.
18–30 ft SAND: very coarse-grained.
30–35 ft SILTY CLAY: grey.
Remarks: Water (14 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1337 (Auger)

0– 2 ft SOIL: grey.
2– 8 ft LOAM: brown, fine- to medium-grained.
8–21 ft SAND: grey to buff, fine-grained, clayey.
21–23 ft SILTY CLAY: light grey.

Remarks: Water (21 ft).

BMP 1338 (Auger)

0– 2 ft SOIL: grey.
2– 9 ft LOAM: buff, fine- to medium-grained.
9–13 ft SILTY CLAY: brown.
13–25 ft SAND: buff, fine-grained passing into grey, medium- to coarse-grained.
25–27 ft GRAVEL: quartz and sandstone pebbles.

Remarks: Water (13 ft).

BMP 1339 (Auger)

0– 2 ft SOIL: brown, silty.
2–15 ft LOAM: buff to brown, very fine-grained.
15–18 ft LOAM: buff, sandy.
18–21 ft SAND: brown, medium- to coarse-grained.
21–28 ft SAND: grey, coarse-grained; small pebbles.
28–32 ft SILTY CLAY: dark grey.

Remarks: Water (21 ft).

BMP 1340 (Auger)

0– 2 ft SOIL: grey to buff, silty.
2– 5 ft LOAM: buff, very fine-grained.
5– 8 ft LOAM: yellow-brown, fine-grained.
8–11 ft LOAM: yellow-brown, medium-grained, sandy.
11–21 ft SAND: buff, fine- to medium-grained.
21–30 ft SAND: grey to dark grey, medium-grained; few sandstone and billy pebbles.
30–32 ft SILTY CLAY: dark grey.

BMP 1341 (Auger)

0– 2 ft SOIL: brown to dark brown, silty.
2– 5 ft LOAM: medium brown, fine-grained.
5– 8 ft LOAM: buff, fine-grained.
8–11 ft LOAM: buff, fine-grained, sandy.
11–28 ft SAND: buff, medium- to coarse-grained passing into grey- coarse-grained; some pebbles.
28–29 ft SILTY CLAY: dark grey.

Logs by: B. R. Houston

BMP 1342 (Auger)

0– 5 ft SOIL: brown, silty, clayey.
5–11 ft LOAM: buff.
11–27 ft SAND: buff, fine- to medium-grained.
27–29 ft SAND: grey, silty, very clayey.

BMP 1343 (Auger)

0–12 ft LOAM: buff.
12–34 ft SAND: buff to light brown to grey, fine- to medium-grained.
34–38 ft CLAY: dark grey to black, carbonaceous.

BMP 1344 (Auger)

0–14 ft LOAM: buff.
14–33 ft SAND: buff to grey, fine- to medium-grained.
33–35 ft CLAY: grey, silty.

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1345 (Auger)

0– 4 ft SOIL: buff.
4–15 ft CLAY: buff to brown, sandy at bottom.
15–34 ft SAND: fine- to coarse-grained, grey; granular.
34–35 ft GRAVEL: grey.

BMP 1346 (Bailer)

0– 5 ft	LOAM: buff.
5 ft– 8 ft	SILT: buff, very clayey.
8 ft–13 ft 6 in.	CLAY: grey-brown, silty.
13 ft 6 in.–16 ft 1 in.	SAND: red-brown, fine-grained.
16 ft 1 in.–22 ft 6 in.	SAND: buff, fine- to medium-grained passing into grey, silty (at base.
22 ft 6 in.–23 ft 7¾ in.	SAND: buff, fine- to very coarse-grained, slightly pebbly.
23 ft 7¾ in.–26 ft 6 in.	SAND: buff, coarse-grained, very pebbly.
26 ft 6 in.–28 ft 6 in.	SAND: buff, very coarse-grained.
28 ft 6 in.–33 ft 1¾ in.	SAND: buff, fine- to medium-grained; charcoal fragments below 31 ft 3 in.
33 ft 1¾ in.–35 ft 5¼ in.	SAND: buff, coarse-grained, pebbly.
35 ft 5¼ in.–35 ft 10¼ in.	No recovery.
35 ft 10¼ in.–36 ft 2¼ in.	CLAY: grey, plastic.

BMP 1347 (Auger)

0–10 ft CLAY: yellow, silty.
10–28 ft SAND: fine-grained, buff to grey.
28–29 ft SAND: brown, pebbly.

BMP 1348 (Auger)

0– 2 ft SOIL: brown, silty.
2–10 ft CLAY: silty, grey to yellow.
10–11 ft LOAM: yellow-brown.
11–39 ft SAND: coarse-grained, grey.
39–44 ft CLAY: grey-green, plastic.

Remarks: Water (11 ft).

BMP 1349 (Auger)

0–23 ft CLAY: chocolate to buff, slightly sandy in part.

Remarks: Water (15 ft).

BMP 1350 (Auger)

0– 3 ft SOIL: grey to buff.
3–21 ft CLAY: grey to brown, plastic.
21–27 ft CLAY: yellow-brown, sandy.
27–30 ft CLAY: grey, plastic.

BMP 1351 (Auger)

0– 5 ft CLAY: grey to buff, semi-plastic.
5–33 ft SAND: yellow to buff to grey, ?clayey.
33–35 ft CLAY: grey, plastic.

Remarks: Water (10 ft).

BMP 1352 (Auger)

0– 8 ft SAND: very fine-grained, buff.
8–27 ft SAND: fine- to medium-grained, yellow to grey.
27–29 ft SILT: clayey, purplish.
29–32 ft CLAY: grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1353 (Auger)

0–14 ft SAND: buff, very fine-grained, slightly clayey.
14–20 ft SAND: fine- to medium-grained, buff; with charcoal.
20–31 ft SAND: coarse-grained, buff to grey; pebbly in part.
31–35 ft CLAY: blue-grey to green-grey, plastic.
Remarks: Moist (14 ft).

Logs by: J. D. Sawers

BMP 1354 (Auger)

0– 2 ft SOIL: grey, silty.
2– 7 ft CLAY: dark brown, sandy.
7–13 ft SAND: buff, fine- to medium-grained.
13–19 ft SAND: grey, medium- to coarse-grained, clayey.
19–23 ft CLAY: grey-brown, sandy.
Remarks: Water (13 ft).

BMP 1355 (Auger)

0– 2ft SOIL: grey, sandy.
2–20 ft CLAY: brown-red to brown-grey, sandy passing into brown to red-brown, sandy.

BMP 1356 (Auger)

0–23 ft CLAY: grey to yellow, brown, silty; sandy in part.

BMP 1357 (Auger)

0– 2 ft SOIL: grey to buff, silty.
2– 5 ft LOAM: buff, fine-grained.
5–11 ft CLAY: grey-brown, sandy.
11–14 ft CLAY: grey to red to brown, plastic.
14–20 ft CLAY: grey-brown, silty.

BMP 1358 (Auger)

0– 1 ft SOIL: grey, clayey.
1– 5 ft CLAY: grey, silty.
5–14 ft CLAY: brown to buff, silty.
14–23 ft CLAY: grey, silty.

BMP 1359 (Auger)

0–14 ft LOAM: buff to light brown, fine-grained.
14–19 ft SAND: grey, fine- to medium-grained.
19–23 ft SAND: grey, medium-grained. silty.

BMP 1360 (Auger)

0– 2 ft SOIL: buff, silty.
2–11 ft CLAY: brown to grey, silty.
11–19 ft CLAY: grey-brown, plastic.
19–20 ft SANDSTONE: yellow-brown, decomposed, argillaceous.

BMP 1361 (Auger)

0– 2 ft SOIL: grey, silty.
2– 8 ft CLAY: grey-brown, semi-plastic.
8–12 ft CLAY: grey-brown, plastic.
12–18 ft CLAY: grey-brown, silty.
18–21 ft SAND: grey, fine-grained, silty.
21–24 ft SAND: grey, medium-grained, some pebbles, silty.
24–29 ft SAND: buff, medium- to coarse-grained, pebbly, clayey.
29–32 ft CLAY: grey-green, plastic.
Remarks: Water (18 ft).

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1362 (Auger)

0– 1 ft SOIL: grey, silty.
1– 8 ft LOAM: buff, fine-grained; decomposed sandstone pebbles, some ferruginous.
8–13 ft CLAY: buff to brown, silty; decomposed SANDSTONE bands.
13–22 ft CLAY: grey, plastic.
22–23 ft SANDSTONE: buff, medium-grained, decomposed, argillaceous.

BMP 1363 (Auger)

0–12 ft LOAM: buff, fine- to medium-grained, sandy.
12–27 ft SAND: buff to brown, silty, fine- to medium-grained.
27–29 ft CLAY: dark grey, some pebbles, silty.

BMP 1364 (Auger)

0–11 ft CLAY: brown to grey mottled, sandy to silty.
11–17 ft CLAY: light to dark grey, plastic.
17–23 ft CLAY: brown, plastic; becoming silty at depth.

BMP 1365 (Auger)

0– 2 ft LOAM: light brown, sandy.
2– 8 ft LOAM: brown, silty.
8–11 ft LOAM: brown and grey mottled, plastic.
11–20 ft CLAY: brown, grey in parts, sandy.
20–23 ft CLAY: brown to grey, plastic.
23–29 ft CLAY: dark grey, plastic.

BMP 1366 (Auger)

0– 5 ft LOAM: buff to brown, fine-grained, sandy.
5–11 ft SAND: brown, medium-grained, silty.
11–21 ft SAND: grey, medium- to coarse-grained; few pebbles.
Remarks: Water (14 ft).

BMP 1367 (Auger)

0– 5 ft LOAM: buff to brown.
5–14 ft CLAY: grey-brown to dark brown, sandy.
14–24 ft SAND: grey to light brown, medium- to coarse-grained; some pebbles.
24–26 ft CLAY: dark grey, silty.
Remarks: Water (14 ft).

BMP 1368 (Auger)

0– 2 ft SOIL: buff to dark grey.
2– 5 ft LOAM: dark brown, sandy.
5–11 ft LOAM: brown to buff, fine-grained, sandy.
11–26 ft SAND: buff, slightly silty, fine- to medium-grained passing into buff to grey, fine- to medium-grained.
26–32 ft CLAY: dark grey-green: weathered SHALE bands.

BMP 1369 (Auger)

0– 6 ft LOAM: dark brown to brown, sandy (fine-grained).
6–17 ft SAND: buff to grey, medium- to coarse-grained; quartz pebbles.
17–20 ft CLAY: dark grey, shaly, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1370 (Auger)

0–15 ft	LOAM: buff to brown, fine- to medium-grained, sandy.
15–18 ft	SAND: brown, fine- to medium-grained, slightly silty.
18–25 ft	SAND: grey, medium- to coarse-grained.
25–26 ft	CLAY: dark grey, plastic.

BMP 1371 (Auger)

0–14 ft	CLAY: grey, silty.
14–17 ft	CLAY: decomposed SANDSTONE bands.
17–22 ft	CLAY: grey, plastic.
22–23 ft	SANDSTONE: decomposed, argillaceous.

BMP 1523 (Auger)

0– 2 ft	SOIL.
2–12 ft	SANDSTONE: buff, fine-grained, decomposed.
12–14 ft	CLAY: grey, semi-plastic, sandy (medium-grained).
14–20 ft	CLAY: light grey, plastic.

BMP 1524 (Auger)

0– 7 ft	SANDSTONE: grey, fine-grained, decomposed, clayey.
7–15 ft	SAND: buff, fine- to medium-grained.
15–20 ft	CLAY: yellow-brown to light grey plastic.

Remarks: Moisture (14 ft).

Logs by B. A. Coxhead

BMP 1758 (Bailer)

0 ft–10 ft 9 in.	LOAM.
10 ft 9 in.–13 ft 7 in.	SAND: buff, fine-grained, clayey.
13 ft 7 in.–15 ft 10¾ in.	SAND: buff, fine- to medium-grained, clean.
15 ft 10¾ in.–16 ft 3½ in.	SAND: buff, fine- to medium-grained, slightly clayey.
16 ft 3½ in.–20 ft 2¼ in.	SAND: light grey, fine- to medium-grained, slightly clayey; wood fragments 17 ft 3 in. to 18 ft 5 in.; thin CLAY band near base.
20 ft 2¼ in–21 ft 10¼ in.	SAND: grey, fine- to medium- to coarse-grained, clean, pebbly.
21 ft 10¼ in.–23 ft 3½ in.	SAND: grey, coarse-grained, clean, pebbly.
23 ft 3½ in.–24 ft 6¾ in.	SAND: light grey, medium-grained, clean, pebbly; clayey at base.
24 ft 6¾ in.–25 ft 8½ in.	SAND: fine- to coarse-grained, with clayey bands.
25 ft 8½ in.–25 ft 10½ in.	SAND: coarse-grained, pebbly.
25 ft 10½ in.–27 ft 1 in.	SAND: coarse-grained, pebbly, very clayey passing into CLAY: sandy (coarse-grained).

6. Portions 285 and 290, Parish of Oxley (Oxley Creek) —continued

BMP 1765 (Bailer)

0 ft–5 ft 6 in.	LOAM: light fawn, sandy.
5 ft 6 in.–7 ft 0½ in.	SAND: dark grey to brown, fine- to medium-grained, clean.
7 ft 0½ in.–8 ft 1 in.	No recovery.
8 ft 1 in.–9 ft 6½ in.	SAND: buff, medium-grained, clean.
9 ft 6½ in.–11 ft 4 in.	SAND: light grey, medium-grained, clean.
11 ft 4 in.–14 ft 6½ in.	SAND: light grey, medium- to coarse-grained, clean; abundant wood fragments.
14 ft 6½ in.–15 ft 0 in.	SAND: light grey, coarse-grained, clean.

Remarks: Bailing stopped by boulder.

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7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek)

Logs by: B. R. Houston

BMP 1258 (Auger)

0– 2 ft	SOIL: brown.
2–20 ft	CLAY: brown-grey, plastic, silty.
20–23 ft	SAND: medium- to coarse-grained, light grey to yellow, slightly clayey.

Remarks: Water (23 ft).

BMP 1259 (Auger)

0– 2 ft	SOIL: light brown.
2– 7 ft	CLAY: light brown, silty.
7–23 ft	SAND: buff, very fine-grained; becoming coarse-grained, granular at base.

Remarks: Water (6 ft).

BMP 1260 (Bailer)

0– 7 ft	CLAY.
7–19 ft 6 in.	SAND: buff, fine-grained.

BMP 1261 (Auger)

0– 2 ft	SOIL: grey.
2– 5 ft	SAND: buff to light grey, fine-grained.
5–14 ft	SAND: light yellow, fine- to medium-grained; with bands decomposed SANDSTONE.
14–18 ft	SAND: buff, fine- to medium-grained.
18–20 ft	SANDSTONE: light grey, fine-grained, decomposed.

Remarks: Water (8 ft).

BMP 1262 (Auger)

0– 5 ft	SAND: light grey, very fine-grained.
5–29 ft	SAND: buff to light brown, fine- to medium-grained; coarse-grained at base.

Remarks: Water (11 ft).

BMP 1263 (Auger)

0– 2 ft	SOIL: grey, silty.
2– 7 ft	SANDSTONE: very fine-grained, buff to grey, clayey.
7–11 ft	CLAY: grey, plastic.
11–14 ft	SILT: grey, clayey.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek) —continued

BMP 1264 (Auger)
0– 2 ft SAND: buff, very fine-grained.
2– 5 ft SILT: light brown, clayey.
5–16 ft SAND: buff, fine- to medium-grained.
16–20 ft CLAY: light grey, sandy.
Remarks: Water (14 ft).

BMP 1265 (Auger)
0– 2 ft SAND: very fine-grained, buff.
2– 5 ft LOAM: yellow, sandy.
5–17 ft SAND: buff, fine- to medium-grained; coarse-grained towards base.
Remarks: Water (4 ft).

BMP 1266 (Auger)
0– 2 ft SAND: very fine-grained, buff.
2–17 ft SAND: fine- to medium-grained, buff to yellow.
Remarks: Water (3 ft).

BMP 1267 (Auger)
0– 5 ft LOAM: grey to buff, very fine-grained, sandy.
5–10 ft CLAY: yellow, sandy.
10–17 ft SAND: buff, fine- to medium-grained; coarse-grained to pebbly towards base.
Remarks: Water (11 ft).

BMP 1268 (Auger)
0– 2 ft SOIL: grey, silty.
2– 5 ft CLAY: medium brown, semi-plastic.
5–11 ft SILTSTONE: buff, decomposed.

BMP 1269 (Auger)
0– 2 ft SAND: very fine-grained, light grey.
2–15 ft SAND: fine- to medium-grained, yellow.
15–17 ft CLAY: light brown.
Remarks: Water (5 ft).

BMP 1270 (Auger)
0– 2 ft SOIL: light grey, very fine-grained.
2– 9 ft SILTSTONE: light grey, decomposed.

BMP 1271 (Auger)
0– 2 ft SOIL: grey.
2– 8 ft CLAY: medium brown to grey, plastic.
8–11 ft CLAY: light blue-grey, slightly ironstained, plastic.

BMP 1272 (Auger)
0– 2 ft SOIL: grey.
2– 8 ft CLAY: brown to grey, plastic.
8–11 ft CLAY: light grey, plastic, slightly ironstained.

BMP 1273 (Auger)
0– 2 ft SAND: very fine-grained, buff.
2– 5 ft SAND: fine-grained, buff.
5–15 ft SAND: fine- to medium-grained, buff.
15–17 ft CLAY: light grey, sandy.
Remarks: Water (5 ft).

BMP 1274 (Auger)
0– 2 ft SOIL: light brown, silty.
2– 4 ft SAND: fine-grained, buff.
4– 5 ft CLAY: brown, plastic.
5–17 ft SAND: fine- to medium-grained, buff.
Remarks: Water (5 ft).

7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek) —continued

BMP 1275 (Auger)
0– 3 ft SOIL: grey, clayey.
3–11 ft SAND: buff, fine- to medium-grained, very clayey.
Remarks: Seepage (6 ft).

BMP 1276 (Auger)
0–14 ft SAND: buff to light grey, very fine- to fine-grained, slightly clayey.
14–17 ft SAND: medium- to coarse-grained, light grey; with CLAY bands.
Remarks: Water (14 ft).

BMP 1277 (Auger)
0– 5 ft SOIL: light brown, sandy.
5–13 ft CLAY: khaki, sandy, plastic.
13–17 ft SAND: fine-grained, light grey.
Remarks: Water (13 ft).

BMP 1278 (Auger)
0– 4 ft SAND: dark grey to yellow.
4–17 ft SAND: fine- to medium-grained, light grey; 1 ft CLAY band, 15–16 ft.
Remarks: Water (5 ft).

BMP 1279 (Auger)
0– 1 ft SOIL: buff.
1– 5 ft SILTSTONE: light brown.
5– 8 ft CLAY: sandy (fine- to medium-grained), buff to yellow.
8–20 ft SAND: fine- to medium-grained, buff to yellow.
Remarks: Water (9 ft).

BMP 1280 (Auger)
0– 2 ft SAND: very fine-grained, white.
2– 5 ft CLAY: brown, plastic, sandy
5–12 ft SAND: fine- to medium-grained, light grey.
12–14 ft CLAY: khaki, sandy.
Remarks: Water (5 ft).

BMP 1281 (Auger)
0–11 ft CLAY: light brown to yellow, silty.

BMP 1282 (Auger)
0– 5 ft CLAY: buff to yellow, silty.
5–17 ft SAND: fine- to medium-grained, light grey; with siliceous pebbles.
Remarks: Water (5 ft).

BMP 1283 (Auger)
0– 5 ft CLAY: yellow-brown, sandy.
5–17 ft SAND: fine- to medium-grained, light grey.
Remarks: Water (5 ft).

BMP 1284 (Auger)
0– 2 ft LOAM: light brown.
2–15 ft CLAY: khaki to grey-brown, silty, semi-plastic.

BMP 1285 (Auger)
0– 5 ft CLAY: brown, semi-plastic.
5– 8 ft SILTSTONE: light grey.
8–20 ft SAND: fine- to medium-grained, light grey to yellow.
Remarks: Water (8 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek) —continued

BMP 1286 (Auger)
0– 7 ft CLAY: brown, semi-plastic.
7– 8 ft SILTSTONE: light grey.
8–14 ft SAND: fine-grained, buff, tight, slightly clayey.
14–17 ft CLAY: grey and brown, plastic.

BMP 1287 (Auger)
0– 2 ft SOIL: loamy.
2–11 ft CLAY: grey-brown, plastic.

BMP 1288 (Auger)
0– 5 ft SAND: buff, very fine-grained, slightly clayey.
5–17 ft SAND: fine- to medium-grained, yellow-white; with band green to grey, CLAY about 15 ft.
Remarks: Water (5 ft).

BMP 1289 (Auger)
0– 9 ft CLAY: brown, silty, semi-plastic.
9–20 ft SAND: fine- to medium-grained, light grey.
Remarks: Water (9 ft).

BMP 1290 (Auger)
0–11 ft CLAY: brown, semi-plastic, slightly sandy at base.

BMP 1291 (Auger)
0– 2 ft SOIL.
2–11 ft CLAY: tightly compacted, brown to grey, sandy.

BMP 1292 (Auger)
0– 5 ft CLAY: brown, plastic.
5–11 ft SANDSTONE: very fine-grained, light grey, decomposed.
11–14 ft CLAY: brown-grey, plastic.

BMP 1293 (Auger)
0– 5 ft SAND: buff, very clayey, very fine-grained.
5– 8 ft CLAY: semi-plastic, dark brown.
8–11 ft SILTSTONE: light grey, decomposed.

BMP 1294 (Auger)
0– 5 ft CLAY: brown, semi-plastic.
5– 8 ft SILTSTONE: light grey, decomposed.
8–20 ft SAND: buff, fine- to medium-grained to coarse-grained at base.

BMP 1295 (Auger)
0– 2 ft SILT: very fine-grained, clayey.
2–11 ft CLAY: brown, sandy, plastic.

BMP 1296 (Auger)
0– 2 ft SOIL: brown.
2–12 ft SAND: fine- to medium-grained, buff.
12–14 ft CLAY: medium grey, plastic.
Remarks: Water (5 ft).

BMP 1297 (Auger)
0– 2 ft SILT: brown.
2–14 ft CLAY: medium grey, plastic.

7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek) —continued

BMP 1298 (Auger)
0– 2 ft SOIL: grey.
2– 5 ft CLAY: khaki, semi-plastic.
5–17 ft SAND: fine- to medium-grained, grey.
Remarks: Water (5 ft).

BMP 1299 (Auger)
0– 2 ft SOIL: brown.
2– 5 ft CLAY: sandy, brown.
5–14 ft SAND: fine- to medium-grained, light grey.
Remarks: Water (4 ft).

BMP 1300 (Auger)
0– 6 ft CLAY: grey-brown, plastic.
6–11 ft CLAY: buff, very sandy.

BMP 1301 (Auger)
0– 2 ft SOIL: brown.
2– 8 ft CLAY: khaki, plastic.
8–20 ft SAND: fine to fine- to medium-grained, light grey.
Remarks: Water (8 ft).

BMP 1302 (Auger)
0– 9 ft SAND: fine-grained, buff, clayey.
9–17 ft SAND: fine- to medium-grained, light grey.
Remarks: Water (9 ft).

BMP 1303 (Auger)
0– 3 ft CLAY: grey-brown, plastic.
3– 5 ft SANDSTONE: yellow, fine-grained, decomposed.
5– 9 ft CLAY: grey-brown, plastic.
9–20 ft SAND: fine- to medium-grained, buff; coarse towards base; with CLAY bands.
Remarks: Water (9 ft).

BMP 1304 (Auger)
0– 2 ft SOIL: grey.
2– 7 ft CLAY: grey-brown, plastic.
7–17 ft SAND: fine- to medium-grained, buff.
Remarks: Water (7 ft).

BMP 1305 (Bailer)
0– 6 ft Open hole.
6–13 ft 3 in. SAND.
13 ft 3 in.–15 ft 8 in. CLAY: very sandy.

BMP 1306 (Bailer)
0– 5 ft Open hole.
5–18 ft 8 in. SAND: fine- to coarse-grained with pebbly bands passing into CLAY: grey, sandy.

BMP 1307 (Bailer)
0– 5 ft Open hole.
5–27 ft 11 in SAND: buff, fine- to very coarse-grained.
27 ft 11 in.–29 ft 3 in. CLAY: light grey, sandy.

BMP 1308 (Bailer)
0– 8 ft Open hole.
8–16 ft 1½ in. SAND: light grey.
16 ft 1½ in.–16 ft 6 in. CLAY: sandy.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

7. Portions 289, 292 and 293, Parish of Oxley (Oxley Creek) —continued

BMP 1309 (Bailer)

0– 5 ft	Open hole.
5–11 ft 3 in.	SAND: buff, very fine-grained.
11 ft 3 in.–11 ft 10 in.	No recovery.
11 ft 10 in.–16 ft 0 in.	SAND: buff, fine- to medium-grained.
16 ft 0 in.–17 ft 3½ in.	SAND: buff, medium-grained, clayey.
17 ft 3½ in.–18 ft 8 in.	CLAY: green, sandy; with rare pebbles.

BMP 1310 (Bailer)

0– 4 ft 11½ in.	Open hole.
4 ft 11½ in.–7 ft 4 in.	SAND: light grey, very fine-grained.
7 ft 4 in.–19 ft 5 in.	SAND: buff, fine- to medium-grained passing into CLAY.

BMP 1311 (Bailer)

0– 6 ft 10 in.	CLAY.
6 ft 10 in.–11 ft 3 in.	SAND: yellow-brown; medium- to coarse-grained, pebbly.
11 ft 3 in.–16 ft 9½ in.	SAND: buff, medium- to coarse-grained, clayey at base.
16 ft 9½ in.–17 ft 7½ in.	CLAY: sandy.

BMP 1312 (Auger)

0– 2 ft	SOIL.
2–10 ft	CLAY: brown, sandy.

BMP 1313 (Auger)

0– 5 ft	SOIL.
5– 8 ft	SANDSTONE: fine, buff, decomposed.
8–10 ft	CLAY: brown, sandy.

BMP 1314 (Auger)

0– 2 ft	SOIL: grey, silty.
2– 5 ft	SILT: medium grey.
5– 7 ft	SILT: medium grey, clayey.
7–12 ft	CLAY yellow-brown, sandy.
12–20 ft	SAND: blue-grey, clayey, fine- to very fine-grained.

BMP 1315 (Auger)

0–17 ft	SAND: fine- to medium-grained, buff; small CLAY band between 8 and 11 ft.

Remarks: Water (5 ft).

BMP 1316 (Bailer)

0– 3 ft 1 in.	SAND: very fine-grained.
3 ft 1 in.–4 ft 10¼ in.	SAND: buff, medium-grained.
4 ft 10¼ in.–13 ft 9 in.	SAND: buff, medium-grained; clayey, 7 to 8 ft.
13 ft 9 in.–16 ft 6 in.	SAND: buff, fine-grained, slightly clayey passing (about 15 ft) into SAND: buff, medium- to coarse-grained; pebbly at base.
16 ft 6 in.–20 ft 4 in.	SAND: buff, fine-grained, slightly clayey below 17 ft 7 in.; medium-grained at base.
20 ft 4 in.–20 ft 8½ in.	SAND: buff, very coarse-grained.
20 ft 8½ in.–21 ft 10 in.	SAND: buff, very coarse-grained, very clayey.
21 ft 10 in.–21 ft 11¾ in.	SANDSTONE: coarse-grained, decomposed.

8. Portion 102, Parish of Yeerongpilly (Oxley Creek)

Logs by: B. A. Coxhead

BMP 1731 (Auger)

0– 2 ft	LOAM.
2– 9 ft	CLAY: light grey; with buff, fine-grained SAND.
9–11 ft 6 in.	SAND: light grey, medium-grained, slightly clayey.
11 ft 6 in.–31 ft	SAND: buff, medium- to coarse-grained, slightly clayey passing (about 18 ft) into yellow, medium- to very coarse-grained, slightly clayey.
31–35 ft	CLAY: grey to dark grey, with pellets of yellow earthy limonite.

Remarks: Water (9 ft).

BMP 1732 (Auger)

0– 2 ft	LOAM: grey to buff.
2–11 ft	SILTSTONE: hard; limonitic, 5–11 ft.
11–29 ft	SAND: buff to cream, medium-to very coarse-grained, slightly clayey.
29–32 ft	CLAY: dark grey, plastic, limonitic.

Remarks: Water (14 ft).

BMP 1733 (Auger)

0– 8 ft	LOAM: grey and buff.
8–23 ft	SAND: buff, fine-grained, slightly clayey; medium-grained below 17 ft.
23–27 ft	SAND: buff, medium-grained, clean.
27–30 ft	SAND: grey, medium-to coarse-grained, clayey.
30–30+ ft	CLAY: grey.

BMP 1734 (Auger)

0–10 ft	LOAM: light grey and buff; few buff clay pellets.
10–15 ft	SAND: mustard, very fine-grained, silty.
15–17 ft	CLAY: light grey, silty, plastic.
17–23 ft	SAND: light grey, medium-grained, slightly clayey.
23–29 ft	SAND: grey, medium-grained, very clayey.
29–35 ft	CLAY: light grey, limonitic in part.

Remarks: Water (17 ft).

BMP 1735 (Auger)

0– 8 ft	LOAM: light buff.
8–12 ft	SAND: yellow, very fine- to medium-grained, slightly clayey.
12–23 ft	SAND: buff to light yellow, medium-to coarse-grained, clean.
23–29 ft	SAND: grey, coarse-grained, slightly clayey.
29–30 ft	CLAY: grey, sandy.
30–38 ft	SAND: grey, very clayey.

BMP 1736 (Auger)

0– 7 ft	LOAM: light grey and grey, sandy.
7–22 ft	SAND: light grey, medium-grained, slightly clayey; few thin bands of clean SAND.
22–23 ft	CLAY: light grey, sandy.

Remarks: Water (9 ft).

BMP 1737 (Auger)

0–10 ft	LOAM: light grey and buff.
10–12 ft	CLAY: light grey, very sandy.
12–23 ft	SAND: light grey, medium-grained, slightly clayey.
23–26 ft	CLAY: light grey and red, limonite-stained, plastic.

Remarks: Water (12 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

8. Portion 102, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1738 (Auger)

0– 2 ft	LOAM: light grey and buff.
2– 8 ft	CLAY: mustard, sandy.
8–11 ft	LOAM.
11–13 ft 6 in.	SAND: cream, fine- to medium-grained, slightly clayey.
13 ft 6 in.–16 ft	CLAY: grey; with SAND bands.
16–25 ft 6 in.	SAND: mustard, fine- to medium-grained, very clayey.
25 ft 6 in.	+SHALE.

Remarks: Water (16 ft).

BMP 1739 (Auger)

0– 5 ft	LOAM: dark grey and light brown.
5–12 ft	CLAY: fawn to light grey, plastic.
12–28 ft 6 in.	SAND: grey, fine- to medium-grained, very clayey.
28 ft 6 in.–29 ft	CLAY: grey, plastic.

Remarks: Water (12 ft).

BMP 1740 (Auger)

0– 5 ft	LOAM: grey to light yellow-brown.
5– 9 ft	SAND: buff to mustard, fine-grained, clayey.
9–13 ft 6 in.	LOAM: fawn to buff.
13 ft 6 in.–21 ft	SAND: buff, medium-grained, clean.
21–27 ft	SAND: grey, medium-grained, clean.
27–29 ft	CLAY: grey, plastic.

Remarks: Water (14 ft).

BMP 1741 (Auger)

0–1 ft 6 in.	LOAM: fawn to grey.
1 ft 6 in.–14 ft	CLAY: yellow to mustard, silty; very sandy below 10 ft.
14–25 ft 6 in.	SAND: buff to cream, fine- to medium-grained, very clayey; slightly clayey in part.
25 ft 6 in.–26 ft	CLAY: grey, plastic.

Remarks: Water (14 ft).

BMP 1742 (Auger)

0– 2 ft	LOAM: grey.
2–17 ft	CLAY: grey and fawn, sandy; yellow below 16 ft.

BMP 1743 (Auger)

0– 8 ft	LOAM: grey to yellow.
8–15 ft	SAND: buff, fine- to coarse-grained, very clayey.
15–24 ft	SAND: grey, medium-grained, clayey to very clayey.
24–26 ft	CLAY: grey, plastic.

Remarks: Water (15 ft).

BMP 1744 (Auger)

0– 6 ft	LOAM: light grey to fawn.
6– 8 ft	SAND: mustard, very fine-grained, slightly clayey.
8–11 ft	CLAY: fawn and light grey, sandy.
11–23 ft	SAND: grey and fawn, fine- to medium-grained, very clayey; 6 in. band, coarse-grained, at base.
23–26 ft	CLAY: yellow; with coarse-grained siliceous SAND.

Remarks: Water (11 ft).

8. Portion 102, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1745 (Auger)

0– 3 ft	LOAM: fawn.
3–12 ft	CLAY: buff to dark fawn, sandy to very sandy.
12–17 ft	SAND: buff to mustard, very clayey.
17–28 ft	SAND: light grey and grey, medium-grained, slightly clayey to clayey.
28–32 ft	SAND: cream, coarse-grained, slightly clayey.

Remarks: Water (12 ft).

BMP 1746 (Auger)

0– 2 ft	LOAM: grey to fawn.
2– 8 ft	CLAY: buff to grey, sandy.
8–11 ft	CLAY: grey, sandy.
11–14 ft	SAND: buff, clean, poorly-sorted.
14–18 ft 6 in.	SAND: cream, medium- to fine-grained, clean.
18 ft 6 in.–21 ft	SAND: very clayey; with sandy CLAY.
21–22 ft	CLAY: grey, sandy, plastic.

Remarks: Water (8 ft).

BMP 1747 (Auger)

0– 2 ft	LOAM: fawn.
2– 9 ft	CLAY: yellow-brown, plastic.
9–11 ft	CLAY: fawn, sandy.
11–18 ft	SAND: buff, fine- to medium-grained, slightly clayey to clean.
18–29 ft	SAND: grey, fine-grained, clean; some black carbonaceous material near base.
29–29+ ft	CLAY.

Remarks: Water (11 ft).

BMP 1748 (Auger)

0– 3 ft	LOAM: light grey.
3–12 ft	CLAY: grey and buff, partly iron-stained, sandy.
12–14 ft	SAND: very clayey.
14–17 ft 6 in.	SAND: buff to cream, medium-grained, clean; slightly clayey at top.
17 ft 6 in.–19 ft	CLAY: grey, sandy.
19–22 ft	SAND: cream, poorly-sorted, clean.
22–23 ft	CLAY: dark grey, plastic.

BMP 1749 (Auger)

0– 2 ft	LOAM: grey.
2–12 ft	CLAY: light grey, fawn and dark grey, plastic.
12–16 ft	SAND: light grey, fine-grained, slightly clayey.
16–27 ft	SAND: buff, coarse-grained, pebbly, clayey passing into grey, fine- to coarse-grained, clayey.
27–31 ft	SAND: very fine-grained; with buff to yellow CLAY.
31–34 ft	CLAY: grey, very sandy, soapy.
34–35 ft	CLAY: light grey, plastic.

Remarks: Water (12 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

8. Portion 102, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1750 (Auger)

0– 2 ft LOAM: light grey.
2–10 ft CLAY: grey, slightly ironstained.
10–13 ft SAND: buff, medium- to fine-grained, slightly clayey.
13–17 ft SAND: light grey, fine-grained, clayey.
17–23 ft CLAY: light grey, slightly ironstained, very sandy, plastic.
Remarks: Water (10 ft).

BMP 1751 (Auger)

0– 2 ft LOAM: light grey.
2–11 ft CLAY: light grey, slightly ironstained; sandy near base.
11–16 ft SAND: buff, fine-grained, clayey.
16–21 ft SAND: light grey, slightly clayey.
21–24 ft SAND: grey, medium-grained, very clayey.
24–26 ft CLAY: light grey, slightly ironstained.
Remarks: Water (11 ft).

BMP 1752 (Auger)

0– 1 ft LOAM: light brown.
1– 8 ft CLAY: light grey to buff, sandy.
8–17 ft SAND: buff to light grey, fine- to medium-grained, clayey.
17–20 ft CLAY: blue-grey, sandy.
Remarks: Water (8 ft).

BMP 1753 (Auger)

0– 3 ft LOAM: light grey.
3–14 ft CLAY: buff, sandy; with very clayey SAND.
14–22 ft SAND: light grey to buff, fine- to medium-grained, clayey; pebbly at base.
22–25 ft SAND: light grey, poorly-sorted, slightly clayey.
25–29 ft CLAY: grey, very sandy to plastic.
29–29+ ft SHALE.
Remarks: Water (14 ft).

BMP 1754 (Auger)

0– 3 ft LOAM: grey.
3–11 ft CLAY: buff and light brown, sandy.
11–18 ft SAND: light grey, fine- to medium-grained, slightly clayey.
18–21 ft SAND: buff, medium- to coarse-grained, clean.
21–23 ft CLAY: grey, sandy.
Remarks: Water (11 ft).

BMP 1755 (Auger)

0– 3 ft LOAM: grey.
3– 9 ft CLAY: brown to dark grey, plastic.
9–16 ft SAND: light grey to cream, very fine-grained, clean.
16–19 ft SAND: buff, fine-grained, slightly clayey.
19–21 ft CLAY: ironstained light grey, plastic.
Remarks: Water (9 ft).

BMP 1756 (Auger)

0– 2 ft LOAM: light grey.
2– 8 ft SAND: fawn, very fine-grained, clean.
8–17 ft SAND: buff to yellow, fine- to medium-grained, very clayey.
17–17+ ft GRAVEL.
Remarks: Water (about 17 ft).

8. Portion 102, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1757 (Auger)

0– 3 ft LOAM: light grey to fawn.
3– 8 ft CLAY: red-brown and grey, sandy.
8–11 ft CLAY: ironstained light grey, plastic.

BMP 1905 (Bailer)

0– 9 ft	LOAM: buff.
9–11 ft	SAND: buff, fine-grained, silty.
11 ft–15 ft 8½ in.	SAND: cream, fine-grained, silty.
15 ft 8½ in.–19 ft 0½ in.	SAND: cream, fine-grained, clean.
19 ft 0½ in.–19 ft 8½ in.	SAND: cream, medium-grained, clean.
19 ft 8½ in.–20 ft 4½ in.	SAND: cream to light grey, medium- to coarse-grained, clean.
20 ft 4½ in.–22 ft 10½ in.	SAND: grey, fine- to medium-grained, clayey to very silty.
22 ft 10½ in.–24 ft 2 in.	SAND: light grey, very fine-grained, slightly silty; carbonaceous fragments.
24 ft 2 in.–26 ft 1½ in.	SAND: light grey, fine-grained, slightly clayey to silty.
26 ft 1½ in.–27 ft 2 in.	SAND: grey, medium-grained, slightly silty.
27 ft 2 in.–27 ft 6 in.	SAND: grey, medium- to coarse-grained, pebbly, clayey.
27 ft 6 in.–27 ft 10 in.	CLAY: light grey to green, very sandy, plastic.

BMP 1906 (Bailer)

0– 8 ft	CLAY: yellow-brown, plastic.
8– 9 ft 9 in.	SAND: cream, fine- to medium-grained, slightly clayey.
9 ft 9 in.–11 ft 3 in.	SAND: cream, fine-grained, slightly clayey.
11 ft 3 in.–15 ft 6 in.	SAND: cream, fine-grained, clean.
15 ft 6 in.–16 ft 11 in.	SAND: cream to light grey, medium-grained, clean.
16 ft 11 in.–23 ft 10 in.	SAND: light grey, medium-grained, clean; pebbly at base.
23 ft 10 in.–26 ft 2 in.	SAND: light grey, fine- to medium-grained, clean, pebbly.
26 ft 2 in.–26 ft 8 in.	SAND: light grey, fine-grained, slightly clayey, with light grey clay pellets.
26 ft 8 in.–27 ft 2 in.	SAND: grey, coarse-grained, pebbly.
27 ft 2 in.–27 ft 6 in.	CLAY: yellow and grey, sandy, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek)

Logs by: B. R. Houston

BMP 1603 (Auger)
0–21 ft CLAY: light grey to yellow, plastic, sandy (fine- to very fine-grained).

BMP 1604 (Auger)
0–12 ft LOAM: buff.
12–19 ft SAND: buff, medium-grained, slightly silty.
19–22 ft SAND: grey, medium-grained, very clayey.
22–23 ft CLAY: grey, plastic.

BMP 1605 (Auger)
0–13 ft LOAM: yellow.
13–30 ft SAND: medium- to coarse-grained, yellow, slightly silty.
30–32 ft CLAY: grey, plastic; sandy at top.

BMP 1606 (Auger)
0–17 ft CLAY: light grey to buff, sandy.
17–20 ft SAND: buff, fine-grained, silty.
20–23 ft CLAY: grey, sandy.

BMP 1607 (Auger)
0–12 ft LOAM: yellow.
12–17 ft SAND: yellow, fine- to medium-grained.
17–20 ft CLAY: grey, plastic.

BMP 1608 (Auger)
0–14 ft CLAY: light brown, silty, very hard.
14–20 ft SAND: buff, medium- to coarse-grained; very clayey below 19 ft 6 in.

BMP 1609 (Auger)
0–14 ft LOAM: buff.
14–25 ft SAND: buff, fine- to medium-grained; clayey below 22 ft.
25–26 ft CLAY: grey, plastic.

BMP 1610 (Auger)
0–14 ft LOAM: yellow.
14–21 ft SAND: fine- to coarse-grained, buff, slightly silty; clayey below 19 ft.
21–23 ft CLAY: grey, plastic.

BMP 1611 (Auger)
0– 2 ft SOIL.
2– 8 ft CLAY: brown, sandy.
8–16 ft LOAM: yellow.
16–29 ft SAND: buff, fine- to medium-grained, clayey.
29–32 ft CLAY: grey, sandy.

BMP 1612 (Auger)
0–17 ft SAND: fine-grained, buff, very clayey.
17–27 ft SAND: medium- to coarse-grained, grey, slightly silty.
27–34 ft SAND: medium-grained, dark grey, very clayey; with coarse pebbles.
34–35 ft CLAY: grey, plastic.

BMP 1613 (Auger)
0– 2 ft SOIL.
2– 6 ft SILTSTONE: buff.
6–18 ft SAND: fine-grained, buff, slightly clayey.
18–26 ft SAND: light brown, very clayey, medium-grained passing into
CLAY: grey, plastic.

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1614 (Auger)
0–11 ft LOAM: buff.
11–20 ft SAND: fine- to medium-grained, buff.
20–26 ft SAND: medium- to coarse-grained, clayey.
26–28 ft CLAY: grey, plastic.
28–29 ft LOAM: coarse-grained, yellow.

BMP 1615 (Auger)
0– 8 ft LOAM: buff.
8–22 ft SAND: medium-grained, buff, clean.
22–24 ft CLAY: grey, very sandy (medium-grained).
24–26 ft CLAY: grey, plastic.

BMP 1616 (Auger)
0–11 ft LOAM: buff.
11–19 ft SAND: medium- to coarse-grained, buff, silty.
19–21 ft SAND: buff to grey, medium- to coarse-grained, very clayey.
21–23 ft CLAY: grey, plastic.

BMP 1617 (Auger)
0– 8 ft LOAM: buff.
8–20 ft SAND: fine- to medium-grained, buff, silty.
20–24 ft SAND: fine- to medium-grained, silty, very clayey.
24–26 ft CLAY: grey, plastic, very sandy (medium-grained).

BMP 1618 (Auger)
0– 5 ft CLAY: grey, plastic.
5–20 ft SANDSTONE: yellow, medium-grained, decomposed, argillaceous.

BMP 1619 (Auger)
0–13 ft CLAY: brown-grey, plastic, sandy at base.
13–17 ft SAND: buff, medium-grained, very clayey.
17–20 ft CLAY: grey, plastic, sandy.

BMP 1620 (Auger)
0–20 ft CLAY: grey-brown, plastic; sandy, 11–20 ft.

BMP 1621 (Auger)
0– 8 ft LOAM: buff.
8–14 ft SAND: buff, medium-grained, clean to silty.
14–28 ft SAND: yellow, medium-grained, very clayey.
28–29 ft CLAY: grey, plastic.

BMP 1622 (Auger)
0– 2 ft CLAY: brown, plastic.
2– 5 ft LOAM: buff.
5–17 ft SAND: medium-grained, yellow, very clayey.
17–20 ft CLAY: grey, plastic, sandy.

BMP 1623 (Auger)
0–10 ft CLAY: medium grey, plastic.
10–14 ft SAND: buff, medium-grained, very clayey.
14–18 ft SAND: buff, fine- to medium-grained, slightly silty.
18–19 ft SAND: buff, medium-grained, very clayey.
19–20 ft CLAY: red and grey, plastic, sandy.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1624 (Auger)

0–10 ft CLAY: grey, plastic.
10–26 ft SAND: buff, fine- to medium-grained, very clayey; GRAVEL at 25 ft.
26–29 ft SANDSTONE: yellow, medium-grained, decomposed.

BMP 1625 (Auger)

0–14 ft CLAY: buff, sandy.
14–19 ft SAND: fine- to medium-grained, buff, slightly silty.
19–23 ft SAND: light grey, coarse-grained, very clayey.

BMP 1626 (Auger)

0–15 ft CLAY: brown-grey, plastic.
15–20 ft SANDSTONE: argillaceous, grey, fine- to medium-grained, decomposed.

BMP 1627 (Auger)

0–15 ft CLAY: grey-brown, plastic.
15–20 ft SANDSTONE: light grey to yellow, coarse-grained, decomposed.

BMP 1628 (Auger)

0– 8 ft LOAM: buff.
8–21 ft SAND: medium- to coarse-grained, buff, silty.
21–23 ft SANDSTONE: grey to yellow, medium- to coarse-grained, decomposed.

BMP 1629 (Auger)

0–11 ft LOAM: buff.
11–19 ft SAND: medium-grained, buff, silty; very clayey below 16 ft.
19–20 ft CLAY: grey, plastic.

BMP 1630 (Auger)

0–17 ft CLAY: brown, semi-plastic.
17–20 ft SAND: buff, coarse-grained, very clayey.

BMP 1631 (Auger)

0–11 ft CLAY: buff, very sandy (fine- to medium-grained), plastic.
11–28 ft 6 in. SAND: medium-grained, buff, very silty.
28 ft 6 in.–29 ft SANDSTONE: medium-grained, red to yellow, decomposed

BMP 1632 (Auger)

0–12 ft CLAY: buff, silty, plastic.
12–21 ft SAND: buff, medium- to coarse-grained, clean; clayey below 19 ft.
21–23 ft CLAY: grey, plastic.

BMP 1633 (Auger)

0– 4 ft CLAY: buff, sandy (fine-grained), plastic.
4–20 ft SAND: fine- to very fine-grained, buff to grey, very clayey.

BMP 1634 (Auger)

0–17 ft SAND: buff to yellow and red, medium-grained, very clayey.
17–20 ft CLAY: grey, sandy (medium-grained).

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1635 (Auger)

0– 5 ft CLAY: buff, sandy (fine-grained).
5–21 ft SAND: fine-grained, buff, very clayey.
21–23 ft SAND: grey, coarse-grained, silty.

BMP 1636 (Auger)

0–13 ft CLAY: brown, silty.
13–17 ft SANDSTONE: light grey-brown, fine- to medium-grained, decomposed.
17–20 ft CLAY: grey, very sandy (medium-grained).

BMP 1637 (Auger)

0–19 ft SAND: buff, fine-grained, silty.
19–24 ft SAND: coarse- to very coarse-grained, grey, silty.
24–26 ft CLAY: grey, plastic.

BMP 1638 (Auger)

0–13 ft LOAM: buff.
13–25 ft SAND: grey, fine- to medium-grained, silty.
25–29 ft SAND: very coarse-grained, gravelly.
29–29+ ft CLAY: grey, plastic.

BMP 1639 (Auger)

0–11 ft LOAM: buff.
11–22 ft SAND: fine- to medium-grained, buff, clean.
22–26 ft SAND: grey, fine- to medium-grained, slightly silty.
26–29 ft SAND: grey, very coarse-grained, pebbly.
29–29+ ft CLAY: grey, plastic.

BMP 1640 (Auger)

0– 8 ft CLAY: buff, soft.
8–24 ft SAND: buff, to light grey, fine- to medium-grained, very clayey.
24–27 ft SAND: grey, medium-grained, slightly silty.
27–29 ft CLAY: black, plastic.

BMP 1641 (Auger)

0– 5 ft LOAM: brown, clayey.
5–22 ft 6 in. SAND: buff to grey, fine- to medium-grained, very clayey.
22 ft 6 in.–23 ft CLAY.

BMP 1642 (Auger)

0– 5 ft LOAM: buff.
5–20 ft SAND: buff, medium- to coarse-grained, clean.
20–26 ft SAND: grey, coarse-grained, pebbly, slightly silty.
26–26+ ft CLAY: grey, plastic.

BMP 1643 (Auger)

0–11 ft LOAM: buff.
11–23 ft SAND: grey, fine- to medium-grained, slightly silty.
23–29 ft SAND: grey, medium- to very coarse-grained, pebbly, very clayey.

BMP 1644 (Auger)

0– 8 ft LOAM: light brown, clayey.
8–14 ft SAND: fine- to medium-grained, buff, very clayey.
14–19 ft SAND: fine- to coarse-grained, buff to grey, slightly silty.
19–20 ft CLAY: grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1645 (Auger)

0–11 ft	CLAY: brown, plastic.
11–18 ft 6 in.	SAND: medium- to very coarse-grained, buff to grey, silty.
18 ft 6 in.–20 ft	CLAY: grey, plastic.

BMP 1646 (Auger)

0– 6 ft	LOAM: buff.
6–26 ft	SAND: buff to grey, fine- to coarse- grained, slightly silty.

BMP 1647 (Auger)

0– 6 ft	CLAY: brown, plastic.
6–27 ft	SAND: buff to grey, fine- to coarse-grained, very clayey.
27–29 ft	CLAY: grey, plastic.

BMP 1648 (Auger)

0–12 ft	CLAY: buff to grey, sandy in part.
12–22 ft	SAND: medium- to coarse-grained, grey, slightly silty.
22–23 ft	CLAY: grey, plastic.

BMP 1649 (Auger)

0–11 ft	LOAM: buff.
11–26 ft	SAND: buff to grey, fine- to coarse-grained; pebbly towards base.
26–32 ft	SAND: grey, coarse-grained, very pebbly, clayey.
32–32+ ft	CLAY: yellow, plastic.

BMP 1650 (Auger)

0–11 ft	SILTSTONE: buff, hard.
11–14 ft	SAND: medium-grained, buff, clean.
14–23 ft	SAND: buff, fine- to medium-grained, very clayey.
23–26 ft	SAND: light grey, coarse-grained, pebbly, slightly silty.

BMP 1651 (Auger)

0–15 ft	CLAY: light brown, sandy, very fine-grained.
15–19 ft	SAND: buff, fine- to medium-grained, very clayey.
19–21 ft	SAND: grey, coarse-grained, silty.
21–23 ft	CLAY: grey, plastic.

BMP 1652 (Auger)

0– 2 ft	SOIL.
2–20 ft	CLAY: buff, brown and grey, plastic, sandy.

BMP 1653 (Auger)

0– 4 ft	CLAY: red-brown, plastic.
4–11 ft	LOAM: buff.
11–23 ft	SAND: medium- to coarse-grained, buff, silty.
23–26 ft	SAND: grey, coarse-grained, silty.
26–29 ft	CLAY: grey to black, very sandy.

BMP 1654 (Auger)

0–15 ft	LOAM: buff.
15–26 ft	SAND: fine- to coarse-grained, buff to grey, slightly silty.
26–29 ft	CLAY: yellow and grey, plastic.

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1655 (Auger)

0–16 ft 6 in.	CLAY: light grey, plastic, very sandy (fine- to medium-grained).
16 ft 6 in.–18 ft	SAND: grey, coarse-grained, silty.
18–20 ft	CLAY: grey, plastic.

BMP 1656 (Auger)

0– 5 ft	CLAY: brown, plastic.
5–11 ft	SAND: light grey, fine- to medium-grained, very clayey.
11–18 ft	SAND: grey, medium- to coarse-grained, slightly silty, with pebbles.
18–20 ft	CLAY: grey, plastic.

BMP 1657 (Auger)

0– 5 ft	SOIL.
5–23 ft	SAND: light grey, fine- to coarse-grained; with GRAVEL from 21 ft; very clayey.

BMP 1658 (Auger)

0– 5 ft	LOAM: buff.
5–18 ft	SAND: fine- to very fine-grained, buff to light grey, very clayey.
18–41 ft	SAND: medium- to coarse-grained, buff to yellow, very silty.

BMP 1659 (Auger)

0–20 ft	CLAY: grey-brown, plastic, sandy.

BMP 1660 (Auger)

0–12 ft	LOAM: buff.
12–36 ft	SAND: medium- to coarse-grained, yellow to buff, silty.
36–44 ft	CLAY: blue-grey, very sandy (coarse-grained to pebbly).

BMP 1661 (Auger)

0–11 ft	LOAM: buff.
11–22 ft	SAND: buff, medium- to coarse-grained, slightly silty in part, pebbly.
22–24 ft	SAND: yellow, coarse-grained, very clayey.
24–26 ft	CLAY: grey, plastic.

BMP 1662 (Auger)

0–15 ft	LOAM: buff; with hard SILTSTONE. 5–8 ft.
15–20 ft	SAND: medium- to coarse-grained, buff, clean.
20–23 ft	SAND: medium- to coarse-grained, buff, very clayey.

BMP 1663 (Auger)

0–15 ft	LOAM: buff.
15–21 ft 6 in.	SAND: buff, medium- to coarse-grained, clean.
21 ft 6 in.–23 ft	CLAY: grey, plastic.

BMP 1664 (Auger)

0– 5 ft	SOIL.
5–13 ft	SILTSTONE: buff, hard.
13–19 ft	SAND: fine- to very fine-grained, buff, silty.
19–23 ft	SAND: coarse-grained, buff, clean; clayey at base.

BMP 1665 (Auger)

0–15 ft	LOAM: buff.
15–33 ft	SAND: fine- to medium-grained, light grey, slightly silty.
33–35 ft	CLAY: grey, plastic; red, sandy (coarse-grained) above 34 ft.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1666 (Auger)
0– 5 ft SOIL: dark.
5–13 ft LOAM: buff.
13–30 ft SAND: medium- to coarse-grained, buff, clean.
30–32 ft SAND: very clayey passing into CLAY: grey, plastic.

BMP 1667 (Auger)
0– 8 ft LOAM.
8–17 ft CLAY: grey to buff, very sandy (fine-grained), plastic.
17–20 ft SAND: medium- to coarse-grained, light grey, very clayey.

BMP 1668 (Auger)
0–15 ft CLAY: buff, very sandy (very fine-grained).
15–23 ft SANDSTONE: buff, grey and red, medium- to coarse-grained, decomposed, argillaceous.

BMP 1669 (Auger)
0– 7 ft LOAM: buff.
7–10 ft SILTSTONE: buff.
10–20 ft SANDSTONE: buff, fine- to medium-grained, decomposed, argillaceous.
20–26 ft CLAY: red and grey, very sandy; with abundant pebbles.

BMP 1670 (Auger)
0–14 ft LOAM: buff.
14–20 ft CLAY: yellow, sandy (medium-grained), plastic.

BMP 1671 (Auger)
0–14 ft LOAM: buff.
14–23 ft SAND: fine- to medium-grained, buff, silty.
23–25 ft SAND: buff, medium- to coarse-grained, very clayey.
25–26 ft CLAY: grey, plastic.

BMP 1674 (Auger)
0–13 ft SANDSTONE: medium-grained, yellow, argillaceous, decomposed.
13–20 ft CLAY: blue-grey, sandy (fine-grained), plastic.

BMP 1675 (Auger)
0– 6 ft SILTSTONE: buff, hard.
6–11 ft LOAM: buff, fatty.
11–20 ft SAND: coarse-grained, yellow, very clayey.
20–23 ft GRAVEL.
23–26 ft SAND: fine-grained, buff, very clayey.
26–29 ft CLAY: grey, plastic; sandy above 27 ft 6 in.

BMP 1676 (Auger)
0– 3 ft SOIL.
3–20 ft SAND: grey, fine- to medium-grained, very clayey; with GRAVEL at base.
20–23 ft CLAY: grey, plastic.

BMP 1677 (Auger)
0– 3 ft SOIL.
3–17 ft SAND: grey, fine- to coarse-grained, very clayey; with grey, plastic CLAY at base.

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1678 (Auger)
0–11 ft LOAM. buff.
11–22 ft SAND: fine- to medium-grained, buff.
22–29 ft SAND: grey, coarse-grained, very clayey; pebbly at top.

BMP 1679 (Auger)
0– 9 ft LOAM: buff.
9–20 ft SAND: fine- to medium-grained, buff, slightly silty.
20–26 ft SAND: grey, medium- to coarse-grained, slightly silty.
26–29 ft CLAY: grey, plastic, sandy.

BMP 1680 (Auger)
0–12 ft LOAM: buff.
12–35 ft SAND: medium- to very coarse- grained.
35–35+ ft CLAY: grey, plastic.

BMP 1681 (Auger)
0– 5 ft LOAM: buff.
5–29 ft SAND: grey, medium- to coarse-grained; very clayey below 26 ft.

BMP 1682 (Auger)
0–13 ft LOAM: grey.
13–17 ft SAND: buff, coarse-grained, clean.
17–20 ft SAND: buff to grey, coarse-grained, very clayey.

BMP 1683 (Auger)
0– 5 ft LOAM: buff.
5– 9 ft 6 in. SILTSTONE: buff, hard.
9 ft 6 in.–14 ft CLAY: buff, very silty .
14–23 ft SAND: medium- to coarse-grained, buff, slightly silty.
23–29 ft SAND: grey, medium-grained, very clayey.

BMP 1684 (Auger)
0–17 ft LOAM: buff.
17–20 ft SAND: buff, coarse-grained.
20–29 ft SAND: light grey, very coarse-grained.
29–32 ft SAND: black to dark grey, coarse-grained, very clayey.

BMP 1685 (Auger)
0–14 ft LOAM: buff.
14–27 ft SAND: buff to grey, coarse-grained; very clayey towards bottom.
27–30 ft CLAY: grey, plastic.

BMP 1686 (Auger)
0–12 ft LOAM: buff.
12–23 ft SAND: grey, fine- to medium-grained, silty to clayey.
23–29 ft CLAY: green to blue-grey, very sandy (fine- to medium-grained).

BMP 1687 (Auger)
0–13 ft SILTSTONE: buff.
13–20 ft SAND: buff, coarse- to very coarse-grained, slightly silty.
20–23 ft SAND: grey, medium-grained, very clayey.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

Logs by: B. A. Coxhead

BMP 1729 (Auger)

0–17 ft	LOAM: buff.
17–23 ft	SAND: clayey, pebbly.

Remarks: Water (20 ft).

BMP 1730 (Auger)

0– 5 ft	LOAM: light grey and fawn; few hard clay pellets.
5–17 ft	CLAY: light grey, plastic, slightly iron-stained; sandy in part, 5 to 6 ft.

BMP 1898 (Bailer)

0– 5 ft	LOAM: fawn.
5–11 ft	SAND: buff, fine-grained, very clayey.
11–13 ft	SAND: cream, fine- to medium-grained, slightly clayey.
13–16 ft 4½ in.	SAND: buff to cream, fine- to medium-grained, clayey.
16 ft 4½ in.–20 ft 4½ in.	SAND: buff to cream, fine-grained, clayey.
20 ft 4½ in.–21 ft 11 in.	SAND: cream, coarse-grained, clayey.
21 ft 11 in.–24 ft 4 in.	SAND: cream, medium-grained, clayey.
24 ft 4 in.–26 ft 0½ in.	SAND: brown, coarse-grained, clayey, slightly pebbly.
26 ft 0½ in.–26 ft 3½ in.	SAND: cream, medium- to coarse-grained; with fine-grained, silty bands.
26 ft 3½ in.–27 ft 5½ in.	SAND: buff, fine- to medium-grained, clayey.
27 ft 5½ in.–29 ft 5 in.	SAND: buff, coarse-grained, clayey to very clayey.
29 ft 5 in.–32 ft 5 in.	SAND: cream, coarse-grained, clean; pebbly with few clay pellets below 29 ft 6 in.
32 ft 5 in.–35 ft 7 in.	SAND: buff, coarse-grained, clean, pebbly passing into CLAY.

BMP 1899 (Bailer)

0– 8 ft	LOAM: buff.
8–11 ft 8½ in.	SAND: buff, fine-grained, slightly clayey to silty.
11 ft 8½ in.–13 ft 6 in.	SAND: buff to cream, fine-grained, silty.
13 ft 6 in.–14 ft 3 in.	SAND: buff to cream, fine- to medium-grained, clayey.
14 ft 3 in.–15 ft 5 in.	SAND: cream, fine-grained, slightly clayey to clayey.
15 ft 5 in.–16 ft 11 in.	SAND: cream, fine-grained, clean to slightly clayey.
16 ft 11 in.–18 ft 0½ in.	SAND: cream, fine-grained, slightly clayey.
18 ft 0½ in.–18 ft 8 in.	SAND: cream, fine- to medium-grained, clean to slightly clayey.

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

18 ft 8 in.–19 ft 11 in.	SAND: buff, medium-grained, slightly clayey to clayey; slightly pebbly in part.
19 ft 11 in.–21 ft 6 in.	SAND: buff, medium-grained, clayey; few sandy clay pellets.
21 ft 6 in.–23 ft 8 in.	SAND: cream, fine- to medium-grained, slightly clayey.
23 ft 8 in.–29 ft 2½ in.	SAND: buff, fine- to medium-grained, silty and clayey.
29 ft 2½ in.–30 ft 10 in.	SAND: fawn to grey, fine-grained, slightly clayey.
30 ft 10 in.–31 ft 5 in.	SAND: fawn to grey, fine-grained, clean.
31 ft 5 in.–32 ft 11½ in.	SAND: dark grey to black; with sandy CLAY.
32 ft 11½ in.–34 ft 0 in.	SAND: dark grey, sandy, slightly pebbly.

BMP 1900 (Bailer)

0– 9 ft 2½ in.	LOAM: buff.
9 ft 2½ in.–10 ft 1½ in.	SAND: buff, very fine-grained, silty.
10 ft 1½ in.–12 ft 10 in.	SAND: buff, fine-grained, clayey to slightly clayey.
12 ft 10 in.–13 ft 10½ in.	SAND: cream, fine-grained, slightly silty.
13 ft 10½ in.–15 ft 0½ in.	SAND: cream, fine-grained, clean.
15 ft 0½ in.–16 ft 1½ in.	SAND: cream, fine- to medium-grained, slightly clayey.
16 ft 1½ in.–17 ft 3 in.	SAND: buff, very fine-grained, clayey passing into CLAY: grey-green, very sandy, slightly pebbly.
17 ft 3 in.–18 ft 4½ in.	CLAY: light grey, soapy, with ironstone nodules.

BMP 1901 (Bailer)

0–11 ft 9 in.	LOAM: buff, sandy.
11 ft 9 in.–14 ft 8 in.	SAND: buff, fine-grained, slightly to very clayey.
14 ft 8 in.–16 ft 6 in.	SAND: cream, fine-grained, slightly clayey to clayey.
16 ft 6 in.–17 ft 8 in.	SAND: cream, fine-grained, silty; few clay pellets.
17 ft 8 in.–18 ft 5½ in.	SAND: cream, fine-grained, silty.
18 ft 5½ in.–20 ft 9 in.	SAND: cream, fine-grained, slightly clayey.
20 ft 9 in.–21 ft 5½ in.	SAND: cream, fine- to medium-grained, clayey.
21 ft 5½ in.–23 ft 0½ in.	SAND: cream, fine-grained, slightly silty and clayey.
23 ft 0½ in.–25 ft 4½ in.	SAND: cream, fine- to medium-grained, clayey.
25 ft 4½ in.–26 ft 6 in.	SAND: cream, medium-grained, clean.
26 ft 6 in.–27 ft 9½ in.	SAND: cream, fine- to medium-grained, clean.
27 ft 9½ in.–28 ft 4 in.	CLAY: buff, pebbly.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1902 (Bailer)

0– 5 ft 7½ in.	LOAM: buff, sandy.
5 ft 7½ in.–7 ft 7½ in.	SAND: buff, fine-grained, slightly silty.
7 ft 7½ in.–9 ft 7 in.	SAND: cream, medium-grained, slightly silty.
9 ft 7 in.–10 ft 2½ in.	SAND: cream to buff, fine- to medium-grained, clean.
10 ft 2½ in.–13 ft 7 in.	SAND: buff, fine-grained, slightly silty.
13 ft 7 in.–15 ft 5 in.	SAND: cream, fine- to medium-grained, clean.
15 ft 5 in.–16 ft 11 in.	SAND: cream to buff, silty.
16 ft 11 in.–18 ft 11½ in.	SAND: buff, silty to slightly clayey.
18 ft 11½ in.–20 ft 2 in.	SAND: cream, fine- to medium-grained, slightly clayey.
20 ft 2 in.–21 ft 8½ in.	SAND: cream, fine- to medium-grained, silty.
21 ft 8½ in.–23 ft 9½ in.	SAND: light grey, medium-grained, slightly clayey; abundant wood fragments.
23 ft 9½ in.–25 ft 8½ in.	SAND: light grey, medium- to coarse-grained, slightly clayey.
25 ft 8½ in.–26 ft 9½ in.	SAND: light grey, coarse-grained, clean passing (about 26 ft) into CLAY: buff, sandy (coarse-grained).

BMP 1903 (Bailer)

0– 4 ft 5 in.	SAND: cream to buff, fine-grained, silty; with a thin light grey CLAY band.
4 ft 5 in.–6 ft 7½ in.	SAND: buff, fine-grained, silty.
6 ft 7½ in.–7 ft 3½ in.	SAND: buff to light brown, fine-grained, very silty.
7 ft 3½ in.–9 ft 9½ in.	SAND: cream, fine- to medium-grained, slightly silty.
9 ft 9½ in.–11 ft 2½ in.	SAND: buff to light grey, fine- to medium-grained, silty.
11 ft 2½ in.–13 ft 6 in.	SAND: grey, fine-grained, very silty, slightly clayey; with charcoal fragments.
13 ft 6 in.–15 ft 4 in.	SAND: grey, fine- to medium-grained, clayey.
15 ft 4 in.–16 ft 6½ in.	SAND: light grey, fine-grained, slightly clayey, pebbly.
16 ft 6½ in.–23 ft 5½ in.	SAND: light grey, medium- to coarse-grained, clayey to slightly clayey passing (about 23 ft) into CLAY: light grey, plastic.

BMP 1904 (Bailer)

0–11 ft 8½ in.	Loam: light grey to buff, sandy.
11 ft 8½ in.–12 ft 9½ in.	SAND: fine-grained, clayey; with interbedded buff LOAM.
12 ft 9½ in.–13 ft 9½ in.	SAND: light grey, fine- to medium-grained, slightly clayey.

9. Portions 99-101, Parish of Yeerongpilly (Oxley Creek) —continued

13 ft 9½ in.–16 ft 9½ in.	SAND: cream to light grey, medium- to coarse-grained, clean; pebbly at base.
16 ft 9½ in.–18 ft 0 in.	SAND: grey, medium- to coarse-grained, clean; few wood fragments.
18 ft 0 in.–18 ft 10½ in.	SAND: grey, medium-grained, slightly clayey and pebbly.
18 ft 10½ in.–20 ft 2½ in.	SAND: grey, medium-grained, slightly clayey; abundant plant material.
20 ft 2½ in.–20 ft 4 in.	SAND: very pebbly; few small wood fragments.
20 ft 4 in.–20 ft 8 in.	SAND: cream, very coarse-grained, clean, pebbly.
20 ft 8 in.–21 ft 10 in.	SAND: light grey, medium- to coarse-grained, slightly clayey.
21 ft 10 in.–22 ft 9 in.	CLAY: light grey to grey-green, sandy, plastic.

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10. Portion 17, Parish of Yeerongpilly (Oxley Creek)

Logs by: B. R. Houston

BMP 1525 (Auger)

0–14 ft	CLAY: light grey to yellow, plastic.
14–20 ft	CLAY: dark blue-grey, plastic.

BMP 1526 (Auger)

0–11 ft	SILTSTONE: buff.
11–17 ft	SAND: buff, very fine-grained, very clayey.
17–23 ft	SAND: grey, fine-grained, very clayey.

Remarks: Water (15 ft).

BMP 1527 (Auger)

0– 2 ft	SOIL.
2–18 ft	CLAY: brown-grey, plastic.
18–20 ft	CLAY: light grey, plastic, sandy (very fine-grained).

BMP 1528 (Auger)

0–14 ft	CLAY: grey, plastic.
14–19 ft	SAND: fine- to medium-grained, buff.
19–20 ft	CLAY: light grey, plastic.
20–23 ft	SAND: medium- to coarse-grained, buff.
23–26 ft	CLAY: medium grey, semi-plastic.

Remarks: Water (14 ft).

BMP 1529 (Auger)

0– 2 ft	SOIL.
2–10 ft	CLAY: grey and brown.
10–17 ft	SAND: buff, fine- to medium-grained, clayey; with small clayey bands.
17–20 ft	CLAY: grey, plastic.

BMP 1530 (Auger)

0–13 ft	CLAY: brown-grey, plastic.
13–17 ft	SAND: buff, fine- to medium-grained, silty.
17–20 ft	CLAY: grey, plastic.

Remarks: Water (13 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1531 (Auger)

0– 2 ft SOIL.
2– 8 ft CLAY: brown.
8–13 ft LOAM: brown.
13–26 ft SAND: medium- to very coarse-grained, buff, slightly silty.
26–29 ft CLAY: grey, plastic.
Remarks: Water (13 ft).

BMP 1532 (Auger)

0– 2 ft SAND: grey, medium-grained, very clayey.
2– 8 ft CLAY: grey, plastic.
8–13 ft SAND: buff to grey, fine- to medium-grained, very clayey.
13–20 ft CLAY: grey-brown, plastic, sandy (fine- to medium-grained).

BMP 1533 (Auger)

0–10 ft CLAY: light grey, very sandy (fine-grained).
10–17 ft SAND: buff, medium-grained, silty.
17–23 ft SAND: buff, medium-grained, very clayey.
Remarks: Water (10 ft).

BMP 1534 (Auger)

0–12 ft LOAM: yellow-brown.
12–25 ft 6 in. SAND: buff, coarse- to very coarse-grained, silty passing into grey, very silty; with GRAVEL at base.
25 ft 6 in.–26 ft CLAY: grey with pebbles.
Remarks: Water (13 ft).

BMP 1535 (Auger)

0–13 ft LOAM: buff; with CLAY bands.
13–25 ft SAND: buff, medium- to coarse-grained, very silty; clayey below 22 ft.
25–26 ft CLAY: grey, pebbly.

BMP 1536 (Auger)

0– 2 ft SAND: buff, medium- to coarse-grained.
2–16 ft CLAY: brown and grey, plastic, sandy in part.
16–19 ft SAND: fine-grained, light grey to buff, coarse-grained, silty.
19–23 ft CLAY: buff, sandy (very coarse-grained).

BMP 1537 (Auger)

0–10 ft CLAY: brown, sandy.
10–28 ft SAND: buff, fine- to medium-grained.
28–30 ft SAND: buff, very coarse-grained, pebbly, slightly clayey.
30–32 ft CLAY: light grey, plastic.

BMP 1538 (Auger)

0– 5 ft CLAY: brown, plastic.
5–11 ft LOAM: buff.
11–28 ft SAND: buff, medium- to coarse-grained, slightly silty.
28–29 ft CLAY: grey, plastic.

BMP 1539 (Auger)

0–11 ft CLAY: buff, sandy (fine-grained).
11–20 ft SAND: buff, fine- to medium-grained, very clayey.

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1540 (Auger)

0–14 ft LOAM: buff to brown.
14–26 ft SAND: buff, medium- to coarse-grained, silty.
26–29 ft CLAY: grey, plastic.

BMP 1541 (Auger)

0– 2 ft SOIL.
2–24 ft SAND: buff, very fine- to very coarse-grained, slightly silty.
24–27 ft SAND: grey, very coarse-grained, slightly silty.
27–29 ft CLAY: grey, plastic.

BMP 1542 (Auger)

0–18 ft SAND: fine- to coarse-grained, buff.
18–23 ft 6 in. SAND: coarse- to very coarse-grained, pebbly, grey.
23 ft 6 in.–26 ft CLAY: brown, plastic.

BMP 1543 (Auger)

0–26 ft SAND: buff to grey, fine- to very coarse-grained.
26–29 ft CLAY: grey, plastic.

BMP 1544 (Auger)

0– 8 ft LOAM: buff, fine- to medium-grained, silty.
8–18 ft 6 in. SAND: buff, medium-grained, slightly silty.
18 ft 6 in.–22 ft 6 in. SAND: buff to light grey, fine-grained, very clayey; with pebbles.
22 ft 6 in.–23 ft CLAY: grey, plastic.

BMP 1545 (Auger)

0– 5 ft LOAM: buff.
5–11 ft SAND: buff, fine-grained, very clayey.
11–29 ft SAND: medium-grained, buff, silty.
29–29+ ft CLAY: with pebbles.

BMP 1546 (Auger)

0– 3 ft CLAY: brown.
3–14 ft LOAM: buff to brown; fatty.
14–21 ft SAND: buff, medium- to coarse-grained, slightly silty near top.
21–23 ft CLAY: grey, plastic.

BMP 1547 (Auger)

0–17 ft SAND: buff to brown, fine-grained, very clayey.
17–20 ft CLAY: grey, silty, plastic.

BMP 1548 (Auger)

0– 5 ft LOAM: brown, very clayey.
5–23 ft SAND: light grey, fine- to medium-grained, silty; coarse-grained at base.

BMP 1549 (Auger)

0– 5 ft CLAY: brown, slightly sandy.
5–24 ft SAND: brown, medium-grained, very silty to clayey.
24–26 ft SAND: grey, very coarse-grained, very silty; with pebbles.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1550 (Auger)

0–11 ft	LOAM: buff.
11–15 ft 6 in.	SAND: buff, medium- to very coarse-grained.
15 ft 6 in.–21 ft 6 in.	SAND: buff, medium- to coarse-grained, very silty.
21 ft 6 in.–26 ft	CLAY: grey, plastic, sandy at top.

BMP 1551 (Auger)

0– 8 ft CLAY: grey, sandy.
8–17 ft CLAY: grey, plastic; carbonaceous at base.
Remarks: Water (14 ft).

BMP 1552 (Auger)

0– 5 ft	SAND: fine-grained, brown to buff, very clayey.
5–12 ft 6 in.	SAND: buff, medium-grained, clayey; with CLAY bands.
12 ft 6 in.–17 ft	CLAY: green-grey, plastic.

Remarks: Water (8 ft).

BMP 1553 (Auger)

0– 2 ft LOAM.
2– 8 ft CLAY: brown, sandy.
8–14 ft SAND: medium-grained, buff, silty.
14–17 ft CLAY: multi-coloured, semi-plastic.

BMP 1554 (Auger)

0– 2 ft	LOAM.
2–24 ft 6 in.	SAND: brown, medium-grained, very clayey.
24 ft 6 in.–26 ft	CLAY: grey, plastic.

BMP 1555 (Auger)

0– 8 ft	CLAY: red-brown, semi-plastic.
8–22 ft 6 in.	SAND: buff to grey, medium- to very coarse-grained, silty.
22 ft 6 in.–23 ft	CLAY: grey, plastic, silty.

BMP 1556 (Auger)

0– 8 ft LOAM: yellow-brown.
8–20 ft SAND: buff, medium-grained, silty.
20–23 ft CLAY: grey, sandy, plastic.

BMP 1557 (Auger)

0–20 ft CLAY: brown to grey, sandy.

BMP 1558 (Auger)

0–10 ft LOAM: buff, fatty.
10–17 ft SAND: medium-grained, buff, very clayey.
17–20 ft CLAY: grey, plastic.

BMP 1559 (Auger)

0– 9 ft	CLAY: buff, very sandy (fine-grained).
9–14 ft	SAND: light grey, fine-grained, very clayey.
14–29 ft	SAND: medium- to very coarse-grained, buff, slightly silty; pebbly at base.
29–29+ ft	CLAY: grey, plastic.

BMP 1560 (Auger)

0–12 ft	CLAY: light grey, buff, sandy.
12–23 ft	SAND: medium- to very coarse-grained, buff to brown, silty; pebbly at base.
23–26 ft	CLAY: grey, plastic.

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1561 (Auger)

0–14 ft	SAND: brown, medium-grained, very clayey.
14–22 ft	SAND: medium- to coarse-grained, buff, silty.
22–25 ft	SAND: coarse-grained, pebbly, clayey.
25–26 ft	CLAY: grey, silty; with pebbles.

BMP 1562 (Auger)

0–11 ft LOAM: buff.
11–14 ft SAND: buff, medium-grained, silty.
14–17 ft CLAY: buff, very sandy.
17–20 ft CLAY: grey, plastic.

BMP 1563 (Auger)

0– 2 ft	SOIL.
2– 8 ft	LOAM: buff to brown.
8–14 ft	SAND: buff, fine-grained, very clayey.
14–25 ft 6 in.	SAND: buff to grey, medium- to very coarse-grained, slightly silty; with CLAY band near base.
25 ft 6 in.–26 ft	CLAY: grey, sandy.

BMP 1564 (Auger)

0– 2 ft SOIL.
2–17 ft SAND: buff to grey, fine- to coarse-grained.
17–21 ft SAND: coarse-grained, grey, very clayey.
21–23 ft CLAY: grey, plastic.

BMP 1565 (Auger)

0– 2 ft	SOIL: clayey.
2–22 ft	SAND: buff, fine- to medium-grained; coarser towards base.
22–24 ft	SAND: grey, very coarse-grained, pebbly, silty.
24–26 ft	CLAY: grey, plastic.

BMP 1566 (Auger)

0– 8 ft	CLAY: brown, very sandy.
8–21 ft	SAND: medium- to coarse-grained, buff, slightly silty.
21–23 ft	SAND: very coarse-grained, buff, very clayey, pebbly.

BMP 1567 (Auger)

0–13 ft	LOAM: brown, fatty.
13–26 ft	SAND: medium- to very coarse-grained, buff, slightly silty; slightly clayey below 22 ft; pebbly at base.

BMP 1568 (Auger)

0–14 ft	LOAM: brown, fatty.
14–26 ft	SAND: medium- to very coarse-grained, buff to grey; pebbly at base.

BMP 1569 (Auger)

0– 4 ft	SOIL.
4–20 ft	SAND: buff, fine- to medium-grained.
20–24 ft	SAND: grey to yellow, medium- to coarse-grained, very silty.
24–26 ft	CLAY: yellow to grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1570 (Auger)
0–14 ft CLAY: buff, silty.
14–20 ft SAND: buff, medium-grained, slightly silty.
20–21 ft 6 in. CLAY: grey, silty.
21 ft 6 in.–23 ft SAND: buff, very coarse-grained; with pebbles.

BMP 1571 (Auger)
0– 8 ft CLAY: brown, silty.
8–11 ft LOAM: buff.
11–22 ft SAND: medium- to coarse-grained, buff.
22–26 ft SAND: grey, very coarse-grained, pebbly; with CLAY bands.
26–26+ ft CLAY: grey, plastic.

BMP 1572 (Auger)
0–21 ft SAND: brown, fine-grained, very silty.
21–24 ft SAND: coarse-grained, grey, pebbly.
24–26 ft CLAY: grey, plastic.

BMP 1573 (Auger)
0–18 ft SAND: fine- to medium-grained, buff to grey.
18–21 ft SAND: grey, very coarse-grained, pebbly.
21–23 ft CLAY: grey, plastic.

BMP 1574 (Auger)
0–15 ft SAND: buff, very fine- to fine-grained, slightly silty.
15–18 ft SAND: fine- to medium-grained, buff.
18–21 ft SAND: grey, very coarse-grained, silty.
21–23 ft CLAY: grey, plastic.

BMP 1575 (Auger)
0– 4 ft SILT: brown.
4–21 ft SAND: brown, medium-grained; very coarse-grained at base.
21–23 ft CLAY: grey, plastic.

BMP 1576 (Auger)
0– 3 ft SOIL.
3– 8 ft SILTSTONE: brown, decomposed.
8–11 ft LOAM: brown, sandy.
11–13 ft ?SANDSTONE: buff, medium-grained, decomposed.
13–23 ft SAND: buff, medium-grained, silty.

BMP 1577 (Auger)
0– 8 ft LOAM: brown.
8–20 ft 6 in. SAND: medium- to coarse-grained, buff, silty.
20 ft 6 in.–23 ft CLAY: grey, plastic.

BMP 1578 (Auger)
0– 2 ft SOIL.
2–21 ft SAND: buff, medium-grained, silty.
21–23 ft CLAY: grey, plastic.

BMP 1579 (Auger)
0–17 ft SAND: fine- to coarse-grained, buff, silty.
17–20 ft CLAY: grey, plastic.

BMP 1580 (Auger)
0–18 ft SAND: light brown to buff, fine- to coarse-grained, silty; with pebbles.
18–23 ft CLAY: grey, sandy (medium-grained).

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1581 (Auger)
0– 8 ft SAND: buff, fine- to coarse-grained, slightly silty.
8–11 ft CLAY: grey, sandy (medium-grained).

BMP 1582 (Auger)
0–17 ft SAND: buff, medium- to coarse-grained, silty.
17–20 ft CLAY: grey, plastic.

BMP 1583 (Auger)
0–17 ft SAND: fine- to medium-grained, buff, very clayey.
17–20 ft CLAY: grey, plastic, very sandy; with GRAVEL below 19 ft.

BMP 1584 (Auger)
0–15 ft 6 in. SAND: buff, fine- to medium-grained, very clayey.
15 ft 6 in.–20 ft CLAY: grey, very sandy.

BMP 1585 (Auger)
0–12 ft LOAM: buff.
12–23 ft SAND: buff, fine- to medium-grained, silty.
23–24 ft 6 in. SAND: buff, fine- to medium-grained, silty, very clayey.
24 ft 6 in.–29 ft CLAY: grey, plastic; very sandy to 27 ft 6 in.

BMP 1586 (Auger)
0– 2 ft SOIL.
2– 8 ft LOAM: brown.
8–11 ft CLAY: light grey, very sandy (fine-grained).
11–21 ft SAND: buff, fine- to coarse-grained; pebbly near base; very clayey below 19 ft.
21–23 ft CLAY: grey, plastic.

BMP 1587 (Auger)
0–15 ft SAND: fine- to medium-grained, buff, very clayey.
15–21 ft CLAY: grey, very sandy.

BMP 1588 (Auger)
0–17 ft SAND: fine- to coarse-grained, buff, very clayey.
17–20 ft CLAY: grey, plastic, very sandy.

BMP 1589 (Auger)
0– 2 ft SOIL.
2– 8 ft SAND. white, very fine-grained.
8–17 ft SAND: buff, fine- to coarse-grained, silty.
17–20 ft CLAY: grey, plastic.

BMP 1590 (Auger)
0– 5 ft CLAY: brown.
5–10 ft SAND: buff, fine- to very fine-grained, clayey.
10–14 ft SAND: buff, medium- to coarse-grained, silty.
14–17 ft CLAY: grey, plastic.

BMP 1591 (Auger)
0–13 ft CLAY: brown, sandy.
13–20 ft SAND: buff, medium-grained, slightly silty.
20–23 ft CLAY: grey, plastic.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1592 (Auger)

0– 5 ft	CLAY: grey to brown, sandy (very fine-grained).
5–19 ft	SAND: buff, medium-grained, slightly silty.
19–20 ft	CLAY: sandy.

BMP 1593 (Auger)

0– 8 ft	LOAM: buff.
8–15 ft	SAND: medium- to coarse-grained, buff, slightly silty.
15–17 ft	CLAY: grey, plastic; sandy at top.

BMP 1594 (Auger)

0– 8 ft	LOAM: buff.
8–12 ft	SAND: buff, medium- to coarse-grained, silty.
12–14 ft	SAND: grey, medium-grained, very clayey.
14–17 ft	CLAY: grey, plastic.

BMP 1595 (Auger)

0– 7 ft	LOAM: buff.
7–17 ft	SAND: coarse-grained, pebbly, very silty.
17–20 ft	CLAY: grey, plastic; sandy at top.

BMP 1596 (Auger)

0–11 ft	LOAM: buff.
11–19 ft	SAND: medium- to coarse-grained, buff, silty.
19–22 ft	SAND: medium- to coarse-grained, buff, silty, clayey.
22–23 ft	CLAY: grey, very silty.

BMP 1597 (Auger)

0–12 ft	CLAY: buff, silty.
12–23 ft	SAND: buff, medium- to coarse-grained; clayey below 22 ft.
23–26 ft	CLAY: grey, sandy.

BMP 1598 (Auger)

0– 6 ft	LOAM: buff.
6–22 ft	SAND: medium- to coarse-grained, buff.
22–23 ft	CLAY: grey, sandy.

BMP 1599 (Auger)

0– 8 ft	SOIL.
8–16 ft	CLAY: grey, very sandy.
16–25 ft	SAND: buff, medium- to coarse-grained, silty.
25–28 ft	SAND: buff, medium- to coarse-grained, silty, clayey.
28–29 ft	CLAY: grey, plastic.

BMP 1600 (Auger)

0–11 ft	SAND: buff, very fine- to fine-grained, clayey.
11–16 ft	SAND: fine- to medium-grained, buff to grey, silty.
16–17 ft	CLAY: grey, plastic.

BMP 1601 (Auger)

0–16 ft	LOAM: buff.
16–23 ft	SAND: fine- to coarse-grained, buff, very silty; clayey below 21 ft.
23–26 ft	CLAY: grey, plastic.

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1602 (Auger)

0–11 ft	LOAM: buff, fatty.
11–26 ft	SAND: buff, fine- to medium-grained, silty.
26–31 ft	SAND: buff, very coarse-grained, pebbly, clayey.
31–32 ft	CLAY: grey, plastic, sandy.

Logs by: B. A. Coxhead

BMP 1759 (Bailer)

0–9 ft 6 in.	SAND: buff, very fine-grained, clayey.
9 ft 6 in.–11 ft 4¾ in.	SAND: fine-grained; with thin CLAY bands.
11 ft 4¾ in.–12 ft 4¼ in.	SAND: buff, fine- to medium-grained.
12 ft 4¼ in.–13 ft 0¼ in.	SAND: buff, fine-grained.
13 ft 0¼ in.–14 ft 11½ in.	SAND: buff, fine- to medium-grained; pebbly in part; clayey in part.
14 ft 11½ in.–15 ft 9¼ in.	SAND: buff, fine- to medium-grained, slightly clayey; thin grey CLAY band.
15 ft 9¼ in.–20 ft 6¾ in.	SAND: buff, medium- to coarse-grained, clean; pebbly at base.
20 ft 6¾ in.–21 ft 11¾ in.	SAND: buff, medium- to coarse-grained, clayey; with clay nodules.
21 ft 11¾ in.–24 ft 8 in.	SAND: buff, medium- to coarse-grained, slightly clayey; pebbly at base.
24 ft 8 in.–24 ft 10½ in.	SAND: buff to cream, medium- to fine-grained, clean; thin CLAY band near base.
24 ft 10½ in.–26 ft 6½ in.	SAND: cream, medium- to coarse-grained, clean, pebbly.
26 ft 6½ in.–27 ft 4 in.	CLAY and SILT: grey, plastic.

BMP 1760 (Bailer)

0– 8 ft	LOAM: light buff.
8–11 ft	SAND: buff, clayey.
11–13 ft 6¾ in.	CLAY: blue-grey, plastic, sandy.
13 ft 6¾ in.–15 ft 6½ in.	SAND: buff, very fine-grained, slightly clayey.
15 ft 6½ in.–18 ft 0¼ in.	SAND: buff, fine- to medium-grained, clean.
18 ft 0¼ in.–20 ft 9 in.	SAND: grey, medium- to coarse-grained, with wood fragments; a few large angular quartzite pebbles below 19 ft 9 in.
20 ft 9 in.–21 ft 11 in.	SAND: grey, coarse-grained, clean; pebbly in part.
21 ft 11 in.–23 ft 7¼ in.	SAND: grey, coarse-grained, very clayey passing (about 23 ft) into CLAY: grey, sandy and pebbly.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

10. Portion 17, Parish of Yeerongpilly (Oxley Creek) —continued

BMP 1761 (Bailer)

0– 5 ft	LOAM.
5–10 ft 2¼ in.	SAND: cream, very fine- to fine-grained, clean.
10 ft 2¼ in.–12 ft 8¾ in.	SAND: buff, fine-grained, very clayey.
12 ft 8¾ in.–14 ft 4 in.	SAND: brown to dark buff, coarse-grained, slightly clayey.
14 ft 4 in.–15 ft 7¾ in.	SAND: buff to grey, coarse-grained, clean.
15 ft 7¾ in.–18 ft 7¾ in.	SAND: grey, medium- to coarse-grained, clean.
18 ft 7¾ in.–20 ft 3¼ in.	SAND: grey, fine- to medium-grained, fairly clean.
20 ft 3¼ in.–22 ft 6 in.	SAND: grey, coarse-grained, clean; pebbly and clayey about 22 ft.
22 ft 6 in.–24 ft 5¾ in.	SAND: grey, coarse-grained, clayey and pebbly.
24 ft 5¾ in.–27 ft 1¾ in.	CLAY: light grey, plastic.

BMP 1762 (Bailer)

0– 5 ft	LOAM: grey to light buff.
5– 8 ft	CLAY: red-brown, very sandy, ironstained.
8–12 ft	SAND: mustard, fine- to medium-grained, clayey.
12–13 ft 4 in.	SAND: buff to cream, fine- to medium-grained, slightly clayey.
13 ft 4 in.–14 ft 7½ in.	SAND: buff, very fine- to fine-grained, slightly clayey.
14 ft 7½ in.–17 ft 0 in.	SAND: buff to cream, medium- to coarse-grained, clean.
17 ft 0 in.–17 ft 8 in.	SAND: buff, fine- to medium-grained, slightly clayey; few small nodules of ironstained clay.
17 ft 8 in.–18 ft 8 in.	SAND: buff, fine-grained, clayey.
18 ft 8 in.–20 ft 2¾ in.	SAND: buff, medium-grained, slightly clayey to clayey.
20 ft 2¾ in.–20 ft 9¾ in.	SAND: buff, medium- to fine-grained, clayey.

BMP 1763 (Bailer)

0– 5 ft	SAND: and LOAM: grey and buff.
5– 8 ft	SAND: buff, clayey to very clayey.
8–11 ft	CLAY: grey and buff, sandy.
11–13 ft 2¾ in.	SAND: buff, medium- to fine-grained, clayey.
13 ft 2¾ in.–16 ft 6¼ in.	SAND: buff, fine-grained, clean.
16 ft 6¼ in.–17 ft 1¾ in.	SAND: buff, medium- to coarse-grained; with few thin CLAY bands.
17 ft 1¾ in.–17 ft 10¾ in.	SAND: buff, medium-grained, clayey to very clayey.
17 ft 10¾ in.–18 ft 7½ in.	SAND: buff, medium- to very coarse-grained, slightly clayey to clayey; pebbly at base.

10. Portion 17, Parish of Yeerongpill (Oxley Creek) —continued

18 ft 7½ in.–20 ft 1½ in.	SAND: buff, medium- to coarse-grained, clayey, pebbly.
20 ft 1½ in.–21 ft 4½ in.	SAND: buff, fine- to medium-grained, clayey to very clayey, slightly pebbly passing into CLAY: sandy.

BMP 1764 (Bailer)

0– 4 ft 6½ in.	LOAM: light grey.
4 ft 6½ in.– 5 ft 8¼ in.	SAND: buff, fine- to very fine-grained, silty and clayey.
5 ft 8¼ in.– 6 ft 2½ in.	SAND: buff, very fine-grained, clean to slightly clayey.
6 ft 2½ in.– 9 ft 0¼ in.	SAND: buff, very fine-grained, slightly clayey.
9 ft 0¼ in.–10 ft 0¼ in.	SAND: buff, fine- to medium-grained.
10 ft 0¼ in.–13 ft 2¾ in.	SAND: buff to cream, fine- to medium-grained, clean; slightly clayey at base.
13 ft 2¾ in.–13 ft 9¼ in.	SAND: light grey, fine- to medium-grained, clayey to very clayey.
13 ft 9¼ in.–14 ft 5¼ in.	SAND: light grey, fine-grained, clayey passing (about 14 ft) into medium- to coarse-grained, very clayey, ironstained.
14 ft 5¼ in.–15 ft 2¾ in.	SAND: coarse-grained, very clayey, pebbly.
15 ft 2¾ in.–15 ft 8¾ in.	CLAY: brown, very sandy, ironstained.

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11. Minor Sand Occurrances

Logs by: J. W. Laycock

BMP 3 (Grid Ref. 948195; Map Sheet 1)

0– 6 ft	SAND: white, fine-grained.
6– 9 ft	SAND: medium-grained, ferruginous.
9–12 ft	SANDSTONE: light grey, medium- to coarse-grained.
12–15 ft	CLAY: brown, soft; few pebbles.
15–18 ft	SAND: light brown, ferruginous; numerous small angular quartz fragments.
18–21 ft	SHALE: dark grey, silty; coal partings.
21–24 ft	SHALE: black.
24–30 ft	SHALE: light to dark brown; numerous small pebbles.
30–33 ft	SAND: light grey.

Remarks: Water (6 ft).

BMP 60 (Grid Ref. 952190; Map Sheet 1)

0– 3 ft	LOAM: grey, sandy.
3–18 ft	SAND: light yellow, fine-grained, yellow to white; few quartz pebbles towards 9 ft; numerous granules and small pebbles, 12–15 ft; sand coarser-grained, 15–18 ft.
18–21+ ft	GRAVEL passing (21–24 ft) into
21+–24 ft	SAND: light grey, medium- to coarse-grained.
24–27 ft	SAND: yellow-brown, medium- to coarse-grained.
27–30 ft	SANDSTONE: grey to yellow-brown, medium-grained; numerous granules and small pebbles.

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

11. Minor Sand Occurrances—continued

BMP 80 (Grid Ref. 911116; Map Sheet 1)
0– 3 ft SAND: medium-grained.
3–12 ft SAND: medium brown; medium-grained.
12–15 ft SILTSTONE or SHALE: medium to dark grey, hard; few small pebbles.

BMP 303 (Grid Ref. 787120; Map Sheet 1)
0– 3 ft LOAM: sandy.
3–12 ft SAND: grey, medium-grained.

BMP 331 (Grid Ref. 770107; Map Sheet 1)
0– 3 ft SAND: fine-grained.
3–12 ft SAND: fine-grained; yellow.
12–18 ft SAND: fine- to medium-grained.
Remarks: Water (18 ft).

BMP 342 (Grid Ref. 799201; Map Sheet 1)
0–15 ft SAND: medium-grained.
15–21 ft CLAY: light grey to yellow; very sandy.

BMP 549 (Grid Ref. 860463; Map Sheet 3)
0– 3 ft MUDSTONE: black to dark brown.
3– 9 ft SAND: brown, medium-grained, fairly clean.
9–24 ft SAND: black, fine-grained, muddy.

BMP 550 (Grid Ref. 867467; Map Sheet 3)
0–15 ft SAND: brown, medium-grained, few small shells.
15–18 ft MUD: black, hard.
18–24 ft SAND: medium- to coarse-grained, muddy; numerous small shells.

BMP 552 (Grid Ref. 830472; Map Sheet 3)
0–18 ft SAND: brown, fine-grained.
Remarks: Water (6 ft).

BMP 553 (Grid Ref. 833480; Map Sheet 3)
0–15 ft SAND: brown, fine-grained, muddy, 12–15 ft.
Remarks: Water (6 ft).

BMP 554 (Grid Ref. 833488; Map Sheet 3)
0–15 ft SAND: fine-grained, brown.
Remarks: Water (6 ft).

BMP 557 (Grid Ref. 854547; Map Sheet 5)
0–15 ft SAND: dark grey to brown; very fine-grained.
Remarks: Water (6 ft).

BMP 559 (Grid Ref. 870530; Map Sheet 3)
0–15 ft SAND: brown, fine-grained.
Remarks: Water (6 ft).

BMP 560 (Grid Ref. 879542; Map Sheet 5)
0– 2 ft SOIL: dark brown, clayey.
2– 9 ft SAND: medium grey to brown, fine-grained.
9–30 ft SAND: medium to dark grey, fine-grained; few small shells; muddy in part, 24–27 ft.
Remarks: Water (6 ft).

BMP 561 (Grid Ref. 877548; Map Sheet 5)
0–15 ft SAND: dark grey, fine-grained; few shells, 9–12 ft.
Remarks: Water (6 ft).

11. Minor Sand Occurrances—continued

BMP 562 (Grid Ref. 859524; Map Sheet 3)
0– 3 ft SILT: medium brown.
3–15 ft SAND: dark grey, fine-grained passing into MUD: black.
Remarks: Water (6 ft).

BMP 563 (Grid Ref. 846502; Map Sheet 3)
0– 3 ft SAND: brown, fine-grained.
3–15 ft SAND: medium grey, fine-grained.
Remarks: Water (6 ft).

BMP 564 (Grid Ref. 842474; Map Sheet 3)
0–15 ft SAND: brown, fine-grained; medium grey, 9–15 ft.
Remarks: Water (6 ft).

BMP 568 (Grid Ref. 796521; Map Sheet 3)
0– 3 ft LOAM: dark brown.
3–15 ft SAND: medium grey, fine-grained.
Remarks: Water (6 ft).

BMP 569 (Grid Ref. 768543; Map Sheet 5)
0– 9 ft SAND: medium brown, fine-grained; few worm casts.
9–12 ft SAND: medium grey to brown.
12–21 ft SILT: grey to black.
21–30 ft CLAY: grey-brown, numerous marine shells; sandy, 24–27 ft.
Remarks: Water (6 ft).

BMP 570 (Grid Ref. 795568; Map Sheet 5)
0– 6 ft SAND: medium brown, fine-grained.
6–12 ft SAND: medium grey, fine-grained; few shells.
12–15 ft SAND: grey to brown, medium-grained.
Remarks: Water (6 ft).

BMP 571 (Grid Ref. 762583; Map Sheet 5)
0– 8 ft SAND: medium brown, fine-grained.
8–13 ft SAND: medium-grey; numerous small shells.
13–15 ft CLAY: blue-grey to dark grey, plastic; numerous small shells.

BMP 618 (Grid Ref. 686041; Map Sheet 1)
0–18 ft SAND: brown, medium-grained.
Remarks: Water (18 ft).

BMP 623 (Grid Ref. 590998; Map Sheet 1)
0– 9 ft SAND: brown, fine-grained.
9–15 ft CLAY: brown, very sandy.
15–18 ft SAND: light grey, fine- to medium-grained.
Remarks: Water (18 ft).

BMP 624 (Grid Ref. 577003; Map Sheet 1)
0–18 ft SAND: light brown, fine-grained.

BMP 629 (Grid Ref. 559027; Map Sheet 1)
0–27 ft SAND: light grey and brown, fine- to medium-grained.
27–30 ft CLAY: blue-grey, plastic.
Remarks: Water (9 ft).

BMP 630 (Grid Ref. 548029; Map Sheet 1)
0–15 ft SAND: light grey, fine-grained.
15–18 ft CLAY: blue-grey, plastic.
Remarks: Water (9 ft).

TABLE X—*continued*

LITHOLOGIC LOGS OF DRILLHOLES IN SAND DEPOSITS—*continued*

11. Minor Sand Occurrances—continued

BMP 634 (Grid Ref. 546060; Map Sheet 1)
0–24 ft SAND: light grey and brown, fine-grained.

BMP 643 (Grid Ref. 548108; Map Sheet 1)
0– 6 ft CLAY: light brown, very sandy.
6–18 ft SAND: grey to light brown, fine-grained.
18–24 ft SILTSTONE: light grey, decomposed.
Remarks: Water (9 ft).

BMP 656 (Grid Ref. 495973; Map Sheet 2)
0–12 ft SAND: light brown, fine-grained.
12–15 ft SAND: light to medium brown, fine-grained.
15–21 ft SAND: medium brown to grey-brown, coarse-grained.
21–24 ft SHALE: green.

BMP 663 (Grid Ref. 528896; Map Sheet 2)
0–18 ft SAND: light brown, very fine-grained.
18–30 ft SAND: light brown, fine- to coarse-grained.
Remarks: Water (21 ft).

BMP 679 (Grid Ref. 540957; Map Sheet 1)
0– 9 ft SAND: brown, fine-grained.
9–12 ft SAND: light grey, fine-grained.
12–24 ft SAND: grey and brown, fine-grained, clayey.

BMP 719 (Grid Ref. 450178; Map Sheet 2)
0– 3 ft CLAY: brown, plastic.
3–24 ft SAND: brown, fine-grained.
Remarks: Water (18 ft).

BMP 724 (Grid Ref. 195075; Map Sheet 2)
0– 6 ft SAND: brown, fine-grained.
6– 9 ft SANDSTONE: brown, coarse-grained; numerous pebbles; very hard.
Remarks: Water (6 ft).

BMP 736 (Grid Ref. 280050; Map Sheet 2)
0–30 ft SAND: medium brown, fine-grained.

BMP 737 (Grid Ref. 285043; Map Sheet 2)
0–30 ft SAND: brown, fine-grained.

BMP 738 (Grid Ref. 292033; Map Sheet 2)
0–12 ft SAND: medium brown, very fine-grained.
12–18 ft SAND: medium brown, fine-grained.
18–42 ft SAND: medium brown, medium-grained.

BMP 739 (Grid Ref. 298026; Map Sheet 2)
0–30 ft SAND: medium brown, fine-grained.

BMP 763 (Grid Ref. 278129; Map Sheet 2)
0– 6 ft SAND: brown, fine- to medium-grained.
6–18 ft SANDSTONE: coarse-grained, decomposed; numerous pebbles up to 1 in.

Logs by: N. A. H. Simmonds

BMP 843 (Grid Ref. 398482; Map Sheet 4)
0– 6 ft SAND: light brown, fine-grained.
6–15 ft SAND: light brown, coarse-grained.
15–21 ft CLAY: dark grey, sandy.
21–24 ft SAND: coarse-grained (= decomposed GRANITE).
Remarks: Water (6 ft).

11. Minor Sand Occurrances—continued

BMP 875 (Grid Ref. 377448; Map Sheet 4)
0– 3 ft LOAM: black.
3– 9 ft SAND: dark brown, clayey.
9–27 ft SAND: light brown, clayey.

BMP 876 (Grid Ref. 377453; Map Sheet 4)
0– 3 ft LOAM: black, clayey.
3– 6 ft SAND: medium- to fine-grained, light brown.
6–42 ft SAND: light brown, medium-grained, clayey (= decomposed GRANITE).

BMP 881 (Grid Ref. 425486; Map Sheet 4)
0– 3 ft LOAM: sandy.
3– 9 ft SAND: medium-grained, blue-grey.
9–18 ft SAND: fine- to medium-grained, light brown.
18–24 ft SAND: clayey, light blue-grey and light brown.
24–30 ft GRANITE: decomposed.

Logs by: J. W. Laycock

BMP 941 (Grid Ref. 778158; Map Sheet 1)
0– 3 ft CLAY: dark brown, plastic.
3–18 ft SAND: light to medium brown, medium- to coarse-grained, clayey; GRAVEL in part, 6–12 ft.

BMP 991 (Grid Ref. 539041; Map Sheet 1)
0–18 ft SAND: medium brown, fine- to medium-grained.
18–24 ft CLAY: medium brown, plastic.
24–30 ft SAND: grey-brown, fine-grained.

BMP 994 (Grid Ref. 545056; Map Sheet 1)
0– 9 ft SAND: medium brown, fine-grained.
9–18 ft CLAY: brown, plastic.
18–27 ft SAND: light brown, fine-grained.
27–30 ft SANDSTONE: light grey, fine-grained, decomposed.

BMP 1031 (Grid Ref. 938283; Map Sheet 3)
0–12 ft SAND: light grey, fine-grained.
12–24 ft SAND: yellow-brown, fine- to medium-grained, clayey.
24–30 ft CLAY: yellow-brown, very sandy (medium-grained).
Remarks: Water (30 ft).

BMP 1037 (Grid Ref. 929275; Map Sheet 3)
0–15 ft SAND: grey, medium-grained, very clayey.
15–36 ft CLAY: medium brown, sandy.

BMP 1103 (Grid Ref. 638703; Map Sheet 5)
0– 6 ft SAND: grey and brown, fine- to medium-grained.
6–12 ft CLAY: medium brown, plastic.
12–30 ft BASALT: decomposed.

BMP 1119 (Grid Ref. 558718; Map Sheet 5)
0– 3 ft CLAY: red, sandy.
3–15 ft SAND: red, very coarse-grained.
15–18 ft CLAY: light grey, plastic.
18–24 ft CLAY: red, plastic
24–30 ft CLAY: brown, plastic.
Remarks: Water (24 ft).

TABLE XI

MECHANICAL ANALYSES OF SAND SAMPLES, OXLEY CREEK*

Sample site	Aperture mm	Percentages by weight: < 0.075 "fines"	0.075 to 0.152 very fine sand	0.152 to 0.251 fine sand	0.251 to 0.353 medium sand	0.353 to 0.699 medium sand	0.699 to 1.676 coarse sand	1.676 to 2.71 very coarse sand	>2.71 gravel	TOTAL
	Passing B.S.S. sieve	200	100	60	44	22	10	6	¼ in.	
	and Retained on B.S.S. sieve	200	100	60	60	44	22	10	6	
Portions 52-55, parish of Oxley										
1. BMP 1517	(7'11¼" - 8' 9¼")	10.6	10.7	29.4	36.5	12.3	0.5	-	-	100.0
2.	(9' 3¼" - 10' 5")	2.4	3.6	11.6	15.7	30.0	35.0	1.6	0.1	100.0
3.	(10' 5" - 10'11¾")	21.8	15.9	15.6	12.0	18.4	14.8	1.0	0.5	100.0
4.	(10'11¾" - 12' 3½")	10.7	5.7	9.9	10.8	23.0	32.8	5.1	2.0	100.0
5.	(12' 3½" - 13' 8¼")	18.1	11.3	22.5	22.7	16.7	6.9	0.8	1.0	100.0
6.	(13' 8¼" - 14' 2")	13.4	9.6	18.3	18.5	24.2	12.7	1.5	1.8	100.0
7.	(14' 2" - 16' 1½")	6.3	5.6	15.8	24.7	31.0	15.4	1.1	0.1	100.0
8.	(17' 0¼" - 18' 5¾")	11.7	7.6	22.0	31.8	20.6	5.8	0.4	0.1	100.0
9.	(18' 5¾" - 20' 7¼")	7.0	3.4	13.1	27.6	37.7	10.4	0.7	0.1	100.0
10.	(20' 7¼" - 21' 3¼")	7.1	5.0	17.0	33.9	31.9	4.8	0.3	-	100.0
11.	(21' 3¼" - 21'11¾")	2.5	4.2	20.2	41.3	28.0	3.7	0.1	-	100.0
12.	(21'11¾" - 24' 8")	16.6	5.6	17.3	16.6	24.8	17.7	0.6	0.8	100.0
13. BMP 1518	(10' 7¼" - 16' 6¾")	11.7	8.8	18.1	21.4	28.6	11.0	0.4	0.1	100.0
14.	(16' 6¾" - 25' 10")	11.1	4.7	12.2	21.9	39.1	10.1	0.6	0.3	100.0
15.	(25' 10" - 29' 1¾")	10.4	2.3	5.1	8.5	26.5	39.2	5.0	3.2	100.0
16. BMP 1519	(11' 1¾" - 24' 0¼")	13.4	7.8	16.1	25.1	33.7	3.8	0.1	-	100.0
17.	(24' 0¼" - 29'10½")	11.1	5.5	10.4	13.6	30.1	24.4	2.2	2.7	100.0
18. BMP 1520	(10'10¾" - 13'11¼")	33.7	19.6	32.3	11.4	2.2	0.6	0.2	-	100.0
19.	(16' 6¾" - 28'11¾")	8.7	5.1	10.8	17.8	39.1	16.9	1.1	0.5	100.0
Portion 358A, parish of Oxley										
20. BMP 1522	(14' 0" - 23' 9¾")	18.2	6.2	13.0	20.0	26.3	12.1	2.8	1.5	100.0
Sub 2 of Portion 356, parish of Oxley										
21. BMP 1521	(14' 3½" - 21' 1¼")	9.2	3.8	7.4	16.1	44.0	16.0	1.8	1.8	100.0
22. BMP 1673	(17' 0" - 23' 7")	5.0	3.4	9.1	29.3	45.5	7.4	0.4	-	100.0
Portion 283, parish of Oxley										
23. BMP 1896	(13' 10" - 23' 1")	6.4	3.7	12.1	22.5	39.8	14.2	1.1	0.2	100.0
24.	(23' 1" - 24' 6½")	3.0	2.9	9.7	19.4	43.8	17.7	1.5	2.0	100.0
25. BMP 1897	(8' 4" - 12' 4½")	8.6	6.9	14.1	20.9	35.8	11.5	1.5	0.7	100.0
26.	(12' 4½" - 15' 9½")	7.7	13.4	37.6	27.5	7.6	4.7	1.1	0.4	100.0
Portions 284 & 286, parish of Oxley										
27. BMP 1890	(9' 1" - 11' 3¼")	15.4	22.0	37.6	20.2	4.5	0.3	-	-	100.0
28.	(11' 3¼" - 15' 6")	12.4	18.7	33.6	24.7	10.1	0.5	-	-	100.0
29.	(15' 6" - 20' 3")	5.1	3.8	9.1	17.8	48.3	15.0	0.8	0.1	100.0
30.	(20' 3" - 22' 4")	5.6	3.9	6.7	10.2	42.0	30.2	1.3	0.1	100.0
31. BMP 1891	(7' 8½" - 10' 4½")	9.5	11.9	28.2	32.7	17.0	0.7	-	-	100.0
32.	(10' 4½" - 14' 7")	2.6	5.1	16.4	25.2	33.4	15.3	1.6	0.4	100.0
33.	(14' 7" - 22' 8½")	1.1	1.2	3.7	9.5	33.4	44.1	5.2	1.8	100.0
34. BMP 1892	(5'10½" - 10' 1½")	9.4	11.4	34.0	28.9	12.3	3.2	0.3	0.5	100.0
35.	(10' 1½" - 14' 2½")	3.4	3.2	8.7	19.4	56.5	8.4	0.3	0.1	100.0
36.	(14' 2½" - 15' 6½")	1.5	2.0	8.2	17.0	39.0	29.9	1.8	0.6	100.0
37.	(15' 7" - 16' 3")	2.9	2.9	7.4	15.1	36.6	31.6	2.9	0.6	100.0
Portions 285 & 290, parish of Oxley										
38. BMP 1346	(14' 1" - 16' 1")	9.0	16.7	43.0	26.4	4.6	0.3	-	-	100.0
39.	(16' 1" - 20'10½")	6.7	13.8	30.1	30.3	18.7	0.4	-	-	100.0
40.	(20'10½" - 22' 6")	2.7	3.5	17.1	35.5	35.8	5.2	0.2	-	100.0
41.	(22' 6" - 23' 8")	3.0	4.0	16.3	30.8	31.9	11.8	1.6	0.6	100.0

TABLE XI .... continued

Passing B.S.S. sieve	200	100	60	44	22	10	6	¾ in.	
and Retained on B.S.S. sieve		200	100	60	44	22	10	6	
Aperture mm	< 0.075	0.075 to 0.152	0.152 to 0.251	0.251 to 0.353	0.353 to 0.699	0.699 to 1.676	1.676 to 2.71	>2.71	TOTAL
Sample site	"fines"	very fine sand	fine sand	medium sand		coarse sand	very coarse sand	gravel	
42. BMP 1346 (23' 8" - 28' 6")	8.1	4.2	6.6	10.2	23.6	20.4	5.1	+21.8	100.0
43. (28' 6" - 28'11¼")	3.7	2.3	8.9	27.4	41.4	10.0	2.7	3.6	100.0
44. (28'11¼" - 31' 3")	1.7	1.8	12.0	35.9	45.4	3.2	-	-	100.0
45. (31' 3" - 35' 5¼")	3.1	1.9	11.3	31.9	39.0	11.4	1.1	0.3	100.0
46. BMP 1758 (10' 9" - 13' 7")	13.9	20.3	34.7	24.5	6.5	0.1	-	-	100.0
47. (13' 7" - 15'10¾")	3.1	5.5	15.6	24.9	45.9	5.0	-	-	100.0
48. (15'10¾" - 17' 3½")	3.7	3.2	9.8	19.6	47.2	16.3	0.1	0.1	100.0
49. (17' 3½" - 20' 2¼")	6.7	6.5	17.7	23.0	27.2	16.1	2.3	0.5	100.0
50. (20' 2¼" - 23' 3½")	3.4	4.9	10.3	14.2	28.0	29.5	6.0	3.7	100.0
51. (23' 3½" - 27' 1")	12.4	3.9	7.4	11.3	30.5	20.9	6.2	7.4	100.0
52. BMP 1765 (5' 6" - 7' 0½")	7.1	10.9	25.6	29.4	25.1	1.9	-	-	100.0
53. (8' 1" - 13' 0")	3.4	5.2	14.0	19.8	36.6	19.4	1.5	0.1	100.0
54. (13' 0" - 15' 0")	2.7	3.6	8.4	17.3	49.0	16.6	1.9	0.5	100.0
Portions 289, 292 & 293, parish of Oxley									
55. BMP 1260 (7' 0" - 12' 0")	12.1	12.5	32.7	39.0	3.7	0.1	-	-	100.0
56. (12' 0" - 17' 0")	10.9	17.9	45.7	23.7	1.7	0.1	-	-	100.0
57. (17' 0" - 19' 6")	7.6	8.4	27.3	39.7	16.1	0.9	-	-	100.0
58. BMP 1305 (6' 0" - 9' 0")	7.5	6.7	19.6	38.1	26.7	1.3	0.1	-	100.0
59. (9' 0" - 13' 3")	5.0	4.0	12.3	25.3	45.0	8.1	0.2	0.1	100.0
60. BMP 1306 (7' 9" - 18' 8")	4.7	6.3	27.3	26.2	28.8	5.6	0.2	-	100.0
61. BMP 1307 (5' 0" - 22' 5")	8.1	7.0	18.0	29.6	29.5	7.5	0.4	-	100.0
62. (22' 5" - 27' 8")	4.4	6.9	17.6	20.3	28.1	21.1	1.5	-	100.0
63. BMP 1308 (10' 0" - 15' 6")	15.8	10.8	19.0	21.3	25.2	6.9	0.7	0.4	100.0
64. BMP 1309 (5' 0" - 10' 2")	20.8	19.6	39.7	17.2	2.3	0.3	0.1	-	100.0
65. (10' 2" - 13' 4½")	13.2	24.4	48.3	9.3	4.3	0.5	-	-	100.0
66. BMP 1310 (4'11½" - 19' 5")	8.0	10.1	23.8	41.1	17.0	0.2	-	-	100.0
67. BMP 1311 (6' 10" - 13' 1¾")	5.5	4.5	14.8	30.5	35.5	8.0	0.6	0.6	100.0
68. (13' 1¾" - 15' 10")	7.7	2.3	7.7	19.2	43.9	18.0	1.0	0.3	100.0
69. BMP 1316 (3' 1" - 13' 9")	8.0	7.9	17.5	29.0	35.3	2.0	0.2	0.1	100.0
70. (13' 9" - 21' 10")	10.9	5.7	16.1	27.1	29.7	9.7	0.5	0.3	100.0
Portion 102, parish of Yeerongpilly									
71. BMP 1905 (9' 0" - 15' 8½")	9.0	13.6	28.5	33.2	15.2	0.5	-	-	100.0
72. (15' 8½" - 20' 4½")	4.2	9.8	21.5	22.8	29.6	11.6	0.5	-	100.0
73. (20' 4½" - 27' 6")	7.0	11.4	22.1	23.8	22.5	9.5	1.8	1.9	100.0
74. BMP 1906 (8' 0" - 11' 3")	6.3	10.1	19.4	36.6	23.8	3.4	0.4	-	100.0
75. (11' 3" - 26' 2")	1.4	3.5	18.3	37.8	33.9	4.2	0.5	0.4	100.0
76. (26' 2" - 27' 2")	1.4	6.2	20.0	19.0	32.0	15.1	3.3	3.0	100.0
Portions 99-101, parish of Yeerongpilly									
77. BMP 1898 (16' 4½" - 20' 4½")	8.1	19.6	43.9	21.0	6.5	0.9	-	-	100.0
78. (20' 4½" - 26' 3½")	13.5	18.8	23.0	15.0	16.6	9.4	1.3	2.4	100.0
79. (26' 3½" - 29' 5")	12.6	9.9	10.9	10.9	26.7	24.2	3.5	1.3	100.0
80. (29' 5" - 35' 1")	4.9	6.3	11.3	17.0	37.5	16.8	3.0	3.2	100.0
81. BMP 1899 (10' 9" - 13' 6")	10.7	17.4	36.2	28.3	7.1	0.3	-	-	100.0
82. (13' 6" - 16' 11")	5.3	13.2	35.7	34.8	10.4	0.6	-	-	100.0
83. (16' 11" - 23' 8")	1.7	6.2	21.8	31.9	34.4	3.7	0.2	0.1	100.0
84. (23' 8" - 31' 5")	4.6	7.9	19.3	29.0	33.7	5.3	0.1	0.1	100.0

* Analyst: G.M. Smith, Engineering Geology Section, Geological Survey of Queensland.

\+ Retained on B.S.S. sieve 6 - 5.3%; ¼" - 7.6%; 3/8" - 8.9%

TABLE XI ....continued

MECHANICAL ANALYSES OF SAND SAMPLES, OXLEY CREEK

Passing B.S.S. sieve / and Retained on B.S.S. sieve		200	100	60	Percentages by weight 44	22	10	6	¾ in.	
			200	100	60	44	22	10	6	
Sample site	Aperture mm	<0.075 "fines"	0.075 to 0.152 very fine sand	0.152 to 0.251 fine sand	0.251 to 0.353	0.353 to 0.699 medium sand	0.699 to 1.676 coarse sand	1.676 to 2.71 very coarse sand	>2.71 gravel	TOTAL
85. BMP 1900	(9' 2½" - 10'11½")	12.2	12.1	30.3	31.1	13.2	1.0	0.1	-	100.0
86.	(11' 10" - 16' 1½")	6.7	10.3	29.4	31.6	18.9	2.8	0.2	0.1	100.0
87. BMP 1901	(11' 9" - 16' 6")	8.6	16.1	42.3	21.0	11.5	0.5	-	-	100.0
88.	(16' 6" - 23' 0¼")	6.9	15.7	44.1	23.9	8.9	0.5	-	-	100.0
89.	(23' 0½" - 27' 9½")	2.3	5.1	24.7	39.6	25.4	2.8	0.1	-	100.0
90. BMP 1902	(5' 7½" - 9' 7")	7.3	9.0	24.1	40.7	18.5	0.4	-	-	100.0
91.	(9' 7" - 15' 5")	9.2	18.1	37.4	26.1	9.0	0.2	-	-	100.0
92.	(15' 5" - 23' 9½")	2.7	8.6	24.2	33.8	28.4	2.2	0.1	-	100.0
93.	(23' 9½" - 26' 3½")	1.3	1.8	5.0	12.2	42.3	32.8	3.8	0.8	100.0
94. BMP 1903	(0' - 11' 2½")	8.7	15.6	33.6	28.2	13.1	0.8	-	-	100.0
95.	(11' 2½" - 15' 4")	8.1	13.2	20.4	25.0	29.1	4.1	0.1	-	100.0
96.	(15' 4" - 22' 7½")	3.7	6.5	16.0	18.9	29.7	16.4	3.5	*5.3	100.0
97. BMP 1904	(12' 9½" - 18'10½")	3.3	4.8	10.8	12.9	33.8	27.4	4.4	2.6	100.0
98.	(18'10½" - 21' 10")	3.1	3.9	7.2	8.8	22.7	32.9	10.9	**10.5	100.0
Portion 17, parish of Yeerongpilly										
99. BMP 1759	(2' - 5')	37.4	26.3	21.3	9.4	5.0	0.6	-	-	100.0
100.	(5' - 9' 6")	32.6	25.1	24.8	11.8	5.3	0.4	-	-	100.0
101.	(11' 4¾" - 13' 0¼")	8.6	11.1	33.1	26.9	16.0	3.9	0.3	0.1	100.0
102.	(13' 0¼" - 15' 9¼")	8.8	12.4	33.3	30.5	13.0	1.9	0.1	-	100.0
103.	(15' 9¼" - 20' 6¾")	3.1	4.2	18.7	31.8	37.4	4.5	0.2	0.1	100.0
104.	(20' 6¾" - 24' 8")	2.5	4.4	18.4	23.4	32.0	17.7	1.1	0.5	100.0
105.	(24' 8" - 26' 6½")	2.9	3.7	14.1	25.8	34.8	16.)	2.1	0.6	100.0
106. BMP 1760	(13' 6¾" - 15' 6½")	11.5	15.5	31.5	24.2	11.3	5.3	0.6	0.1	100.0
107.	(15' 6½" - 18' 0¼")	3.2	6.5	22.9	32.3	31.9	3.1	0.1	-	100.0
108.	(18' 0¼" - 21' 8¾")	2.9	2.3	7.7	16.0	41.2	26.6	2.6	0.7	100.0
109. BMP 1761	(5' - 10' 2½") (12' 8¾" - 14' 4")	5.2	7.0	18.0	23.6	34.0	11.2	0.9	0.1	100.0
110.	(14' 4" - 15' 7¾")	6.7	7.7	18.1	21.2	32.0	14.0	0.3	-	100.0
111.	(15' 7¾" - 24' 5¾")	2.8	2.9	10.0	18.5	45.6	16.3	2.2	1.7	100.0
112. BMP 1762	(14' 7½" - 18' 8")	3.3	3.6	11.3	24.3	47.5	0.9	0.1	-	100.0
113.	(18' 8" - 20' 9¾")	3.6	2.9	9.6	22.8	52.0	8.7	0.3	0.1	100.0
114. BMP 1763	(13' 2¾" - 16' 6¼")	7.8	15.4	33.2	25.7	15.4	2.1	0.2	0.2	100.0
115.	(16' 6¼" - 17'10¾")	5.9	9.7	24.2	29.7	23.5	4.4	1.4	1.2	100.0
116.	(17'10¾" - 21' 4½")	2.7	3.2	11.4	24.1	35.7	18.4	2.8	1.7	100.0
117. BMP 1764	(5' 8¼" - 9' 0¼")	16.8	27.1	35.6	15.4	4.7	0.4	-	-	100.0
118.	(9' 0¼" - 13' 2¾")	4.9	9.1	25.7	35.9	22.9	1.5	-	-	100.0
119.	(13' 2¾" - 15' 2¾")	4.2	4.4	12.0	24.8	43.2	9.8	1.1	0.5	100.0

*Retained on B.S.S. sieve 6 - 1.7%; ¼" - 0.4%; 3/8" - 3.2%.

**Retained on B.S.S. sieve 6 - 6.6%; ¼" - 2.3%; 3/8" - 1.6%.

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APPENDIX

LITHOLOGIC LOGS OF DRILLHOLES NOT INCLUDED IN TABLES III, VIII OR X.

Logs by: B. R. Houston

BMP 1 (Grid Ref. 955211; Map Sheet 3)

0– 0+ ft LOAM: grey, sandy
passing (0–3 ft) into
0+–12 ft SANDSTONE: yellow, decomposed.
12–15 ft CLAY: green, nodular, waxy.

BMP 2 (Grid Ref. 942202; Map Sheet 1)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: red, medium-grained.
3– 9 ft SANDSTONE: yellow, medium-grained.
9–27 ft CLAY: red and grey mottled, sandy; rock pebbles, 15 ft–18 ft and 24–27 ft.
27–30 ft CLAY and SHALE: light grey, carbonaceous.
30–33 ft CLAY: sandy.
33–36 ft CLAY: yellow and grey.

Remarks: Water (33 ft).

Log by: J. W. Laycock

BMP 6 (Grid Ref. 920190; Map Sheet 1)

0– 0+ ft LOAM: yellow grey, sandy
passing (0–3 ft) into
0+– 6 ft CLAY: grey, sandy.
6–12 ft SANDSTONE: light grey to red, medium-grained.

Logs by: B. R. Houston

BMP 7 (Grid Ref. 900190; Map Sheet 1)

0– 0+ ft LOAM: yellow, sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: red to yellow, medium-grained.
3– 4 ft SANDSTONE: hard ferruginous.

BMP 8 (Grid Ref. 890200; Map Sheet 1)

0– 4 ft CLAY: red; with quartzite pebbles.

Logs by: J. W. Laycock

BMP 9 (Grid Ref. 904198; Map Sheet 1)

0– 0+ ft SAND: clayey
passing (0–3 ft) into
0+– 3 ft SAND: red, clayey.
3–18 ft CLAY: red and white mottled, very sandy; few quartz pebbles from 6 ft.
18–21 ft CLAY: white, very sandy.
21–33 ft CLAY: red, sandy.

BMP 10 (Grid Ref. 905210; Map Sheet 3)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SAND: clayey.
3–15 ft SANDSTONE: grey, decomposed.

BMP 12 (Grid Ref. 900220; Map Sheet 3)

0–15 ft SANDSTONE: grey, medium-grained, decomposed; numerous small quartz pebbles from 6 ft.

BMP 13 (Grid Ref. 890220; Map Sheet 3)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: medium-grained; decomposed.
3– 9 ft SANDSTONE: light grey, fine- to medium-grained; numerous highly siliceous fragments; decomposed.
9–12 ft SANDSTONE: grey; numerous quartzite fragments.

BMP 14 (Grid Ref. 910220; Map Sheet 3)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: mottled.
3–15 ft SANDSTONE: grey, medium-grained, decomposed.

BMP 16 (Grid Ref. 808232; Map Sheet 3)

0– 3 ft SANDSTONE: red, weathered.
3– 6 ft SANDSTONE: white, weathered.

BMP 18 (Grid Ref. 943221; Map Sheet 3)

0– 3 ft CLAY: sandy.
3– 7 ft CLAY: blue-grey, plastic.
7– 9 ft SANDSTONE: red, medium-grained, very hard.

BMP 20 (Grid Ref. 928227; Map Sheet 3)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 6 ft CLAY: red.
6– 9 ft CLAY: blue-grey; few small quartz pebbles.
9– 9+ ft CLAY: grey
passing (9–12 ft) into
9+–15 ft CLAY: white to grey, sandy; occasional small quartz fragments.
15–18+ ft CLAY: grey, sandy
passing (18–21 ft) into
18+–21 ft SANDSTONE: red, ferruginous, hard.

BMP 21 (Grid Ref. 909230; Map Sheet 3)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: red, weathered.
3– 3+ ft SANDSTONE: grey, clayey
passing (3–6 ft) into
3+– 6 ft SANDSTONE: yellow-brown, ironstained.
6–15 ft SANDSTONE: grey to mustard-coloured, medium-grained.

BMP 40 (Grid Ref. 958210; Map Sheet 3)

0– 3 ft LOAM and CLAY: sandy.
3– 6+ ft SILTSTONE: light grey, ironstained
passing (6–9 ft) into
6+– 9 ft SANDSTONE: ironstained, fine-grained.
9–15 ft BASALT: decomposed; with green waxy material.
15–18 ft BASALT: brown to grey, decomposed.
18–21 ft BASALT: light grey, decomposed.

Log by: I. G. Sanker

BMP 42 (Grid Ref. 930210; Map Sheet 3)

0– 3 ft SOIL and CLAY: grey to white, ironstained.
3–12 ft CLAY: grey, sandy; some weathered SANDSTONE, 9–12 ft.
12–15 ft CLAY: grey, sandy and brown to black, carbonaceous.

APPENDIX—continued

Logs by: J. W. Laycock

BMP 44 (Grid Ref. 929228; Map Sheet 3)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft CLAY: red, hard.
3– 3+ ft SANDSTONE: light grey, medium-grained, ironstained
passing (3–6 ft) into
3+– 9 ft SANDSTONE: very hard, ferruginous.

BMP 46 (Grid Ref. 951220; Map Sheet 3)
0– 3 ft SANDSTONE: medium-grained, weathered.
3– 3+ ft CLAY: grey and red
passing (3–6 ft) into
3+– 6 ft BASALT: light grey to greenish.
6–18 ft BASALT: greenish-yellow, decomposed.
18–21 ft BASALT: black, dense, hard.

BMP 47 (Grid Ref. 947229; Map Sheet 3)
0– 3+ ft SANDSTONE: yellow-brown, decomposed.
passing (3–6 ft) into
3+– 9 ft CLAY: red and grey mottled.
9–12 ft SANDSTONE: honey-brown.
12–18 ft SANDSTONE: light grey, medium-grained, decomposed; light grey SHALE in part, 15–18 ft.
18–18+ ft CLAY: light grey, sandy
passing (18–21 ft) into
18+–21 ft CLAY: red.
21–21+ ft CLAY: blue-grey
passing (21–24 ft) into
21+–24 ft SAND: light grey, medium-grained.
24–30 ft SANDSTONE: light grey, medium-grained.
Remarks: Water (24 ft).

BMP 48 (Grid Ref. 972220; Map Sheet 3)
0– 0+ ft SOIL: red
passing (0–3 ft) into
0+– 3 ft CLAY: red and grey.
3–15 ft BASALT: green to yellow, waxy, decomposed.
15–18 ft BASALT: very weathered.

BMP 49 (Grid Ref. 932201; Map Sheet 1)
0– 3 ft SILTSTONE: light grey, weathered.
3– 9 ft SANDSTONE: light grey, medium-grained; few milky quartz pebbles, 6–9 ft.
9–12 ft CONGLOMERATE: pebbles.

BMP 50 (Grid Ref. 948202; Map Sheet 1)
0– 0+ ft Hillwash
passing (0–3 ft) into
0+– 6 ft SANDSTONE: ferruginous, decomposed.

BMP 51 (Grid Ref. 908199; Map Sheet 1)
0– 9 ft SANDSTONE: yellow-brown, decomposed.
9–12 ft CLAY: white, plastic; sandy in part.
12–15 ft SANDSTONE: red, weathered; with ferruginous nodules and carbonaceous fragments.
15–21 ft CLAY: light grey; with ferruginous siltstone nodules.
21–24 ft SHALE: red.
24–27 ft SHALE: greenish, ironstained, hard.

BMP 52 (Grid Ref. 882195; Map Sheet 1)
0– 3 ft SHALE: light brown.
3– 6 ft SHALE: yellow-brown.
6– 9 ft SHALE: light yellow to white.
9– 9+ ft PHYLLITE: white; clayey when wet.

BMP 53 (Grid Ref. 913182; Map Sheet 1)
0– 6 ft SANDSTONE: yellow-brown, medium-grained, decomposed.
6–12 ft CLAY: red and blue-grey mottled; sandy, 9–12 ft.
12–21 ft SANDSTONE: light grey, medium-grained, weathered; ironstained in part.
21–24 ft SANDSTONE: medium-grained, ferruginous.

BMP 54 (Grid Ref. 893161; Map Sheet 1)
0– 3 ft CLAY: white, sandy.
3– 6 ft SHALE: light brown, soft.
6– 9 ft CLAY: light grey to white, sandy.
9–12+ ft SANDSTONE: brown to red, medium-grained, weathered
passing (12–15 ft) into
12+–15+ ft SHALE: black
passing (15–18 ft) into
15+–18 ft SANDSTONE and SHALE: occasional small pebbles.

BMP 55 (Grid Ref. 893170; Map Sheet 1)
0– 3+ ft SANDSTONE: yellow-brown, weathered; few small angular white fragments
passing (3–6 ft) into
3+– 6 ft QUARTZITE.
6– 6+ ft GRAVEL: with quartzite pebbles
passing (6–9 ft) into
6+– 9 ft SANDSTONE: weathered.
9–12+ ft SANDSTONE: light grey, fine- to medium-grained, weathered.
passing (12–15 ft) into
12+–15 ft CLAY: sandy.

BMP 57 (Grid Ref. 880160; Map Sheet 1)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+–15 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 59 (Grid Ref. 937204; Map Sheet 1)
0– 0+ ft LOAM: yellow-brown, sandy
passing (0–3 ft) into
0+–12 ft CLAY: yellow-brown, sandy; numerous quartz fragments.

BMP 61 (Grid Ref. 926182; Map Sheet 1)
0– 6 ft CLAY: black.
6– 9 ft CLAY: black, sandy.
9–12 ft SILTSTONE: light grey.
12–15 ft SANDSTONE: light grey to yellow; numerous small quartz fragments and pebbles.

BMP 62 (Grid Ref. 974125; Map Sheet 1)
0– 9 ft SHALE: red; soft.

BMP 63 (Grid Ref. 975137; Map Sheet 1)
0– 3+ ft SAND: yellow, medium-grained
passing (3–6 ft) into
3+– 6 ft CLAY: red and grey mottled, very sandy.
6– 9 ft SANDSTONE: red to grey, decomposed.
9–15 ft SANDSTONE: light grey, medium-grained, decomposed; occasional small pebbles.

APPENDIX—continued

BMP 64 (Grid Ref. 959140; Map Sheet 1)
0– 0+ ft CLAY: brown
passing (0–3 ft) into
0+– 6 ft SANDSTONE: red, decomposed.
6–12 ft SANDSTONE: light grey, fine- to medium-grained.
12–15 ft SANDSTONE: yellow-brown, medium-grained.

BMP 66 (Grid Ref. 951157; Map Sheet 1)
0– 3 ft SANDSTONE: brown, decomposed.
3–15 ft SANDSTONE: light grey, decomposed.

BMP 67 (Grid Ref. 942170; Map Sheet 1)
0– 3 ft SANDSTONE: brown, weathered.
3–15 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 68 (Grid Ref. 938160; Map Sheet 1)
0– 3 ft CLAY: grey, sandy.
3– 9 ft SILTSTONE: light brown, weathered.
9–12 ft CLAY: light brown, sandy.
12–15+ ft SAND: light grey, medium-grained
passing (15–18 ft) into
15+–18 ft GRAVEL.
18–21 ft GRAVEL and SAND.
Remarks: Water (12–15 ft).

BMP 69 (Grid Ref. 958122; Map Sheet 1)
0–12 ft SHALE: green; with some quartzite.

BMP 70 (Grid Ref. 953140; Map Sheet 1)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft SANDSTONE: decomposed.
3– 6+ ft CLAY: red and grey mottled, sandy; few pebbles
passing (6–9 ft) into
6+–15+ ft SANDSTONE: grey, medium-grained, weathered; very ironstained in part, 12–15 ft
passing (15–18 ft) into
15+–18 ft SILTSTONE and CLAY: light grey, sandy.
18–21 ft SANDSTONE: dark red-brown; medium-grained.

BMP 72 (Grid Ref. 947130; Map Sheet 1)
0– 3 ft CLAY: very sandy.
3– 6 ft SILTSTONE: light grey, weathered.
6– 9 ft SANDSTONE: light grey to white, fine- to medium-grained, weathered.
9–12 ft SANDSTONE: red, medium-grained, weathered.
12–15 ft SANDSTONE: white medium-grained, weathered.

BMP 73 (Grid Ref. 925142; Map Sheet 1)
0– 0+ ft SILT: clayey.
passing (0–3 ft) into
0+– 6 ft CLAY: light grey, sandy.
6– 9 ft CLAY: medium brown, sandy.
9–12+ ft SAND: medium brown, medium-grained; numerous small quartz pebbles
passing (12–15 ft) into
12+–15 ft SAND: yellow-brown; with numerous small pebbles.
15–18 ft SANDSTONE: light grey, fine-grained, weathered; ferruginous in part.
18–21 ft SANDSTONE: light grey, fine- to medium-grained, weathered.

BMP 74 (Grid Ref. 930130; Map Sheet 1)
0– 0+ ft SOIL: sandy
passing (0–3 ft) into
0+– 3 ft CLAY: sandy.
3– 6 ft CLAY: very sandy, ironstained.
6–12 ft SANDSTONE: light grey, fine-grained.
12–15 ft SANDSTONE: light grey, medium-grained, weathered; ironstained in part.

BMP 75 (Grid Ref. 910130; Map Sheet 1)
0– 3 ft CLAY: brown.
3–21 ft SANDSTONE: light grey, medium-grained, ironstained.

BMP 78 (Grid Ref. 922102; Map Sheet 1)
0– 0+ ft CLAY: brown
passing (0–3 ft) into
0+–21 ft SHALE: white to light yellow; with occasional quartz pebbles towards base.

BMP 79 (Grid Ref. 912115; Map Sheet 1)
0– 6 ft CLAY: grey-brown, sandy, plastic.
6– 9 ft CLAY: brown, sandy, plastic passing into SAND: fine- to medium-grained, clayey.
9–12 ft SAND: fine- to medium-grained, clayey.
12–21 ft SAND: light grey, medium- to coarse-grained; few small quartz pebbles.
21–24 ft SILTSTONE: medium grey; few small pebbles.

BMP 82 (Grid Ref. 890130; Map Sheet 1)
0– 3 ft SHALE: brown, hard.
3– 6 ft SHALE: medium to dark grey, hard.
6– 9 ft SANDSTONE: red, very fine-grained; micaceous.

BMP 83 (Grid Ref. 879127; Map Sheet 1)
0– 0+ ft CLAY: brown
passing (0–3 ft) into
0+– 3 ft SHALE: brown.
3–12 ft SHALE: light brown, clayey in part.
12–15 ft SANDSTONE: ironstained, very fine-grained.

BMP 85 (Grid Ref. 884108; Map Sheet 1)
0– 6 ft CLAY: medium brown, very sandy.
6–12 ft SAND: light grey, coarse-grained; numerous quartz pebbles up to ¼ in.
12–15 ft SAND: medium to dark brown, fine- to medium-grained; clayey.
15–18+ ft SAND: light grey, fine- to medium-grained
passing (18–21 ft) into
18+–21 ft SANDSTONE: yellow, fine-grained.
21–24 ft SANDSTONE: light grey, fine- to medium-grained.

BMP 90 (Grid Ref. 910143; Map Sheet 1)
0– 0+ ft SAND: light grey
passing (0–3 ft) into
0+– 6 ft SANDSTONE: grey, medium- to coarse-grained; decomposed, 3–6 ft.
6–15 ft SANDSTONE: light grey, fine-grained; weathered and ironstained.

BMP 91 (Grid Ref. 924157; Map Sheet 1)
0– 9 ft SANDSTONE: light grey, fine-grained; ironstained and weathered.
9–15 ft SANDSTONE: light grey, medium- to coarse-grained, weathered.

APPENDIX—continued

BMP 92 (Grid Ref. 923173; Map Sheet 1)

0– 3 ft CLAY: white and brown.
3–12 ft SILTSTONE: medium brown and SHALE: grey-brown.
12–15 ft SANDSTONE: light grey, fine-grained grading into medium-grained.

BMP 93 (Grid Ref. 930180; Map Sheet 1)

0–15 ft SANDSTONE: light grey, medium-grained, decomposed; ironstained.

BMP 95 (Grid Ref. 896150; Map Sheet 1)

0– 3 ft SANDSTONE: yellow-brown, decomposed.
3– 6 ft SANDSTONE: grey to red, decomposed.
6– 9 ft SANDSTONE: light grey to white, decomposed.
9–15 ft SANDSTONE: light grey, fine- to medium-grained.

Log by: I. G. Sanker

BMP 108 (Grid Ref. 827178; Map Sheet 1)

0– 0+ ft SOIL passing (0–3 ft) into
0+– 3 ft CLAY: red, white and grey.
3–12 ft CLAY: red and white, sandy; 6 in. quartzitic pebbles at base.

Logs by: J. W. Laycock

BMP 110 (Grid Ref. 815180; Map Sheet 1)

0– 3 ft CLAY: very sandy; ironstained.
3–18 ft SANDSTONE: yellow; very fine- to fine-grained; laminated in part.

BMP 116 (Grid Ref. 829122; Map Sheet 1)

0– 3 ft LOAM: sandy; clayey near bottom.
3–30 ft CLAY: grey, ironstained; very sandy.

BMP 118 (Grid Ref. 839112; Map Sheet 1)

0–12 ft SOIL: red, clayey; numerous small milky quartz pebbles, 6–12 ft.
12–15 ft SANDSTONE: medium-grained, very heavily ironstained; occasional small pebbles.
15–24 ft SANDSTONE: fine- to medium-grained, very clayey, ironstained; light grey to white when not ironstained, 18–24 ft.

BMP 119 (Grid Ref. 837102; Map Sheet 1)

0–12 ft SOIL: red, clayey; few small angular quartz pebbles, 6–12 ft.
12–24 ft SANDSTONE: medium-grained, heavily ironstained; occasional rounded pebbles.
24–30 ft CLAY: white, plastic.

BMP 121 (Grid Ref. 808083; Map Sheet 1)

0– 9 ft SANDSTONE: light brown, ironstained and weathered; clayey, 6–9 ft.
9–15 ft SANDSTONE: light grey, fine- to medium-grained, weathered.
15–21 ft SANDSTONE: light grey, medium-grained, weathered; few small quartz pebbles, 15–18 ft; numerous small quartz pebbles, 18–24 ft.

BMP 122 (Grid Ref. 809090; Map Sheet 1)

0– 0+ ft CLAY: black, very sandy passing (0–3 ft) into
0+– 3 ft SANDSTONE: light grey, fine- to medium-grained, weathered.
3–12 ft SANDSTONE: red, medium to coarse-grained; numerous small quartz pebbles.
12–21 ft SANDSTONE: light grey, medium-grained; weathered.
21–27+ ft CLAY: blue-grey, plastic passing (27–30 ft) into
27+–30 ft SANDSTONE: very weathered, clayey.

BMP 123 (Grid Ref. 811100; Map Sheet 1)

0– 9 ft CLAY: white to grey; ironstained.
9–15 ft SILTSTONE: light grey, clayey in part; some brown CLAY towards base.
15–18 ft CLAY: medium grey to brown, plastic.
18–21 ft SANDSTONE: red, medium-grained, weathered.
21–24 ft SANDSTONE: light grey, medium-grained, weathered.
24–27 ft CLAY: blue-grey, plastic.
27–27+ ft CLAY: red brown to yellow-brown passing (27–30 ft) into
27+–30 ft SANDSTONE: red to yellow-brown, medium-grained.

BMP 125 (Grid Ref. 793077; Map Sheet 1)

0– 3 ft SOIL: red, clayey, sandy.
3– 9 ft SANDSTONE: red, medium- to coarse-grained, clayey; very weathered; very hard at base.

BMP 128 (Grid Ref. 849094; Map Sheet 1)

0– 9 ft SOIL: red, clayey.
9–15 ft SANDSTONE: red, medium-grained, hard.
15–21 ft CLAY: white to red, plastic; few ironstone pebbles, 18–21 ft.

BMP 132 (Grid Ref. 901078; Map Sheet 1)

0– 3 ft LOAM: sandy.
3– 6 ft CLAY: red, sandy.
6–12 ft SANDSTONE: light red, medium-grained, weathered.
12–15 ft SANDSTONE: light grey, medium-grained, weathered.

BMP 135 (Grid Ref. 904107; Map Sheet 1)

0– 3 ft SANDSTONE: brown, medium-grained; ironstained and weathered.
3– 6 ft SANDSTONE: light grey to white, medium-grained; decomposed.
6– 9 ft SANDSTONE: red and brown, medium-grained, decomposed.
9–15 ft SANDSTONE: white, fine- to medium-grained; decomposed.

BMP 136 (Grid Ref. 903112; Map Sheet 1)

0– 3 ft LOAM: sandy.
3–12 ft CLAY: grey, sandy; ironstained, 3–6 ft.
12–15 ft SANDSTONE: white, decomposed.

BMP 137 (Grid Ref. 892080; Map Sheet 1)

0– 3 ft LOAM: sandy.
3–18 ft SANDSTONE: white, fine-grained.

APPENDIX—continued

BMP 138 (Grid Ref. 885086; Map Sheet 1)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 3 ft	SANDSTONE: clayey.
3–18 ft	SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 140 (Grid Ref. 866070; Map Sheet 1)

0–12+ ft	SANDSTONE: red to brown, medium-grained; ironstained and weathered passing (12–15 ft) into
12+–15 ft	SANDSTONE: white, medium-grained, weathered.
15–18 ft	SANDSTONE: white, medium-grained; weathered; shaly towards bottom.
18–30 ft	SHALE: light grey, soft; occasional ironstained nodules.

BMP 141 (Grid Ref. 862066; Map Sheet 1)

0– 6 ft	SANDSTONE: red to brown, medium-grained, clayey.
6– 9 ft	SANDSTONE: light grey to white, fine- to medium-grained, decomposed.
9–21 ft	SANDSTONE: brown, fine- to medium-grained, decomposed.
21–21+ ft	SANDSTONE: white to grey, medium- to coarse-grained, weathered passing (21–24 ft) into
21+–24 ft	SANDSTONE: yellow, fine- to medium-grained, ironstained.

BMP 142 (Grid Ref. 866070; Map Sheet 1)

0– 3 ft	SANDSTONE: light grey, medium-grained; weathered and ironstained.
3–15 ft	SANDSTONE: medium grey, medium-grained, decomposed.
15–18+ ft	SANDSTONE or SAND: medium grey; numerous angular milky quartz pebbles passing (18–21 ft) into
18+–21 ft	SHALE: soft.
21–27 ft	SHALE: black to dark grey, soft; numerous small quartz pebbles.

BMP 147 (Grid Ref. 888062; Map Sheet 1)

0– 9 ft	SANDSTONE: light grey to light brown, fine-grained; decomposed, ironstained.
9–15 ft	SANDSTONE: light grey, medium-grained; decomposed.
15–18 ft	SANDSTONE: light grey to light brown, medium- to coarse-grained.

BMP 150 (Grid Ref. 893048; Map Sheet 1)

0– 6 ft	SHALE: brown to medium grey.
6– 9 ft	SANDSTONE: red, fine-grained; hard, ironstained.
9–15 ft	SANDSTONE: light grey, fine-grained.
15–21 ft	SANDSTONE: light grey and yellow, fine-grained, decomposed.

BMP 152 (Grid Ref. 874047; Map Sheet 1)

0– 6+ ft	CLAY: blue-grey, very sandy passing (6–9 ft) into
6+ –9 ft	GRAVEL: mustard yellow; pebbles up to ¼ in.
9– 15 ft	SANDSTONE: light grey to brown, decomposed; few pebbles.
15–21 ft	SHALE: medium grey; few small pebbles.

BMP 155 (Grid Ref. 855063; Map Sheet 1)

0– 3+ ft	CLAY: light yellow-brown, plastic passing (3–6 ft) into
3+– 6 ft	CLAY: grey.
6– 9 ft	CLAY: grey and calcareous; numerous medium sand grains.
9– 9+ ft	CLAY: blue-grey, very sandy passing (9–12 ft) into
9+–12 ft	GRAVEL: clayey.
12–15 ft	SAND: medium- to coarse-grained, clayey.
15–18 ft	CLAY: white, plastic.
18–21 ft	CLAY: grey to brown, sandy.
21–24 ft	SHALE: medium to dark grey, micaceous; numerous carbonaceous fragments.

Remarks: Water (24 ft).

BMP 160 (Grid Ref. 828057; Map Sheet 1)

0– 6 ft	LOAM: yellow, sandy.
6– 9+ ft	CLAY: light grey, plastic passing (9–12 ft) into
9+–12 ft	SANDSTONE: medium- to coarse-grained, decomposed.
12–18 ft	SANDSTONE: yellow-brown, coarse-grained; decomposed.
18–21 ft	SANDSTONE: red to brown, medium- to coarse-grained; decomposed.
21–24 ft	SANDSTONE: red, ferruginous; hard.

BMP 162 (Grid Ref. 836060; Map Sheet 1)

0– 0+ ft	LOAM: sandy passing (0–3 ft) into
0+– 3 ft	SANDSTONE: medium-grained, decomposed; ferruginous sandstone nodules.
3– 9 ft	SANDSTONE: red, coarse-grained; decomposed.
9–18 ft	CLAY: white to light grey, plastic.
18–21 ft	SILTSTONE: light grey, decomposed.
21–27 ft	CLAY: light grey, very sandy.
27–30 ft	SAND: light grey, very fine-grained.
30–33 ft	CLAY: brown, sandy.
33–36 ft	SANDSTONE: light grey, fine-grained, decomposed.

Remarks: Water (36 ft).

BMP 164 (Grid Ref. 840073; Map Sheet 1)

0– 3 ft	SANDSTONE: red, medium-grained; 6 in. of SOIL at top.
3– 9 ft	SANDSTONE.

BMP 165 (Grid Ref. 836075; Map Sheet 1)

0– 6 ft	SOIL: red, clayey.
6–15 ft	SANDSTONE: light red, medium-grained.

BMP 166 (Grid Ref. 833082; Map Sheet 1)

0– 3 ft	SOIL: red, clayey.
3–18 ft	SANDSTONE: red, medium-grained, decomposed.

BMP 167 (Grid Ref. 843080; Map Sheet 1)

0–18 ft	SOIL: red, clayey; few small quartz pebbles up to ¼ in., 12–15 ft.

BMP 168 (Grid Ref. 835090; Map Sheet 1)

0–15 ft	SOIL: red, clayey.
15–18 ft	SANDSTONE: red, medium-grained; few small quartz pebbles.
18–24 ft	SANDSTONE: light red to brown, fine- to medium-grained, decomposed.

APPENDIX—continued

BMP 169 (Grid Ref. 826092; Map Sheet 1)

0– 6+ ft SOIL: red, clayey
passing (6–9 ft) into
6+– 9 ft SANDSTONE: red, hard; ferruginous.
9–15 ft SANDSTONE: yellow-brown, medium-grained.

BMP 170 (Grid Ref. 820075; Map Sheet 1)

0– 3 ft LOAM: yellow-brown, sandy.
3– 9 ft SANDSTONE: yellow-brown, medium-grained, decomposed.
9–12 ft SANDSTONE: yellow-brown, medium-grained; numerous hard red medium-grained ferruginous sandstone nodules.
12–15 ft SANDSTONE: light grey to white, medium-grained; decomposed.
15–24 ft CLAY: light grey, plastic.

BMP 171 (Grid Ref. 823092; Map Sheet 1)

0– 3 ft SOIL: light red, sandy, clayey.
3– 6 ft SANDSTONE: red, medium-grained, decomposed.
6–15+ ft SANDSTONE: red, fine-grained, decomposed
passing (15–18 ft) into
15+–18 ft SANDSTONE: light grey, fine-grained, decomposed.
18–27 ft SANDSTONE: light grey to brown, decomposed.
27–27+ ft SANDSTONE: light grey to white, medium- to coarse-grained
passing (27–30 ft) into
27+–33 ft SANDSTONE: coarse-grained, decomposed.
33–33+ ft SANDSTONE: red to brown, fine- to medium-grained, decomposed
passing (33–36 ft) into
33+–36 ft GRAVEL: numerous angular to sub-rounded pebbles.

BMP 172 (Grid Ref. 824097; Map Sheet 1)

0– 9 ft SOIL: red, clayey.
9–12+ ft SANDSTONE: light grey to yellow-brown, medium- to coarse-grained; numerous hard red sandstone pebbles
passing (12–15 ft) into
12+–18+ ft GRAVEL with SANDSTONE; numerous small quartz pebbles; red below 18 ft
passing (18–21 ft) into
18+–21 ft CLAY: light grey to white.
21–24 ft SANDSTONE and CLAY: red, hard, white.
24–27 ft SANDSTONE: light red to brown, medium-grained; numerous small rounded hard red sandstone pebbles.

BMP 173 (Grid Ref. 822084; Map Sheet 1)

0– 6 ft SOIL: red, clayey.
6– 9 ft SANDSTONE: red, medium-grained, decomposed.
9–12 ft SANDSTONE: red to yellow-brown, medium-grained, decomposed.
12–15 ft SANDSTONE: yellow-brown, medium-grained decomposed.
15–21 ft SANDSTONE: yellow-brown, medium- to coarse-grained, decomposed.

BMP 176 (Grid Ref. 816099; Map Sheet 1)

0– 0+ ft LOAM: yellow, sandy
passing (0–3 ft) into
0+– 3 ft CLAY: red.
3– 6 ft CLAY: red and yellow, semi-plastic.
6– 9 ft CLAY: red and grey; few sand grains.
9–12+ ft CLAY: light grey, plastic
passing (12–15 ft) into
12+–15 ft CLAY: red and grey, sandy; numerous granules and small pebbles.
15–18 ft CLAY: light grey, dry.
18–21 ft CLAY: light grey to brown; numerous small ironstone pebbles.
21–33 ft CLAY: light brown and grey, plastic; sandy, 27–30 ft; few hard red ferruginous sandstone nodules, 30–33 ft.
33–39 ft CLAY: light grey, plastic.
39–42 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 177 (Grid Ref. 819058; Map Sheet 1)

0–12 ft SANDSTONE: yellow-brown, medium-grained, decomposed.
12–21 ft SANDSTONE: light grey to yellow-brown, medium- to coarse-grained.
21–24 ft SANDSTONE: red, medium-grained; few small hard red ferruginous pebbles.

BMP 178 (Grid Ref. 809060; Map Sheet 1)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft CLAY: red, sandy.
3–15 ft SANDSTONE: light grey to light brown, fine-grained, decomposed; small light grey SHALE interbed between 12 and 15 ft.
15–18 ft SANDSTONE: red-brown, fine- to medium-grained; decomposed.
18–24 ft SANDSTONE: red-brown, medium- to coarse-grained; decomposed.
24–27 ft SANDSTONE and GRAVEL: brown, very coarse-grained; decomposed.
27–30 ft SANDSTONE: brown, medium- to coarse-grained; decomposed.

BMP 179 (Grid Ref. 799062; Map Sheet 1)

0– 3 ft BASALT: weathered.
3– 6 ft BASALT.

BMP 180 (Grid Ref. 788063; Map Sheet 1)

0– 3 ft CLAY: red, sandy; very fine-grained.
3– 6 ft SHALE: medium brown to yellow.
6– 6+ ft SHALE: greenish
passing (6–9 ft) into
6+–12 ft BASALT: greenish, decomposed.

BMP 181 (Grid Ref. 796064; Map Sheet 1)

0– 3 ft SOIL: dark red, clayey; sandy in part.
3– 6 ft CLAY: medium brown, plastic.
6–12 ft BASALT: greenish, decomposed, hard.
12–18 ft CLAY: greenish-brown; few basalt pebbles.
18–21 ft CLAY: yellow, very plastic.
21–30 ft SHALE: dark grey, carbonaceous.
30–33 ft SHALE: light grey.
Remarks: Water (15 ft).

BMP 182 (Grid Ref. 789066; Map Sheet 1)

0– 3 ft SOIL: red, clayey.
3–24 ft SANDSTONE: light grey to brown, fine-grained, decomposed.
24–27 ft SANDSTONE: mustard-coloured, medium-grained, decomposed.

APPENDIX—continued

BMP 183 (Grid Ref. 800070; Map Sheet 1)

0– 3 ft SOIL: red, clayey, sandy.
3– 6 ft CLAY: red to brown, sandy.
6–12 ft SANDSTONE: yellow-brown, fine- to medium-grained; few hard red sandstone pebbles; becomes coarser towards bottom.
12–18 ft SANDSTONE: red, hard, ferruginous; decomposed in part.
18–21 ft CLAY: red to grey, sandy; numerous ironstone pebbles.
21–30 ft CLAY: light grey, plastic.

BMP 184 (Grid Ref. 813067; Map Sheet 1)

0– 9 ft SANDSTONE: red, fine-grained, decomposed; numerous rounded hard red sandstone pebbles near bottom.
9–12 ft SANDSTONE: light brown, medium- to coarse-grained; decomposed.
12–15+ ft SANDSTONE: light brown, coarse-grained
passing (15–18 ft) into
15+–18 ft CLAY: light brown to grey, sandy;
18–21 ft CLAY and SANDSTONE: coarse-grained decomposed.
21–24 ft CLAY: light grey, sandy.

Remarks: Water (18 ft).

BMP 185 (Grid Ref. 826048; Map Sheet 1)

0– 9 ft SANDSTONE: red to brown, fine- to medium-grained, decomposed; numerous hard red sandstone nodules towards bottom.
9–15+ ft SANDSTONE: medium brown, medium- to coarse-grained, decomposed
passing (15–18 ft) into
15+–18 ft CLAY: grey and red.
18–27 ft CLAY: light grey, plastic.
27–27+ ft IRONSTONE: red, hard
passing (27–30 ft) into
27+–30 ft CLAY: brown.

BMP 186 (Grid Ref. 824040; Map Sheet 1)

0– 9 ft SANDSTONE: light grey, coarse-grained, decomposed.
9–21 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 187 (Grid Ref. 814038; Map Sheet 1)

0– 6+ ft SANDSTONE: medium brown, medium-grained, decomposed; numerous small red ferruginous sandstone pebbles from 3 ft
passing (6–9 ft) into
6+–9 ft CLAY: red and grey mottled.
9–12 ft CLAY: red and grey mottled, plastic.
12–15 ft SANDSTONE: medium brown, medium-grained, decomposed.
15–18 ft SANDSTONE: light grey to white, fine-grained.
18–24 ft SANDSTONE: medium brown, fine-grained, decomposed.

BMP 191 (Grid Ref. 904196; Map Sheet 1)

0– 3 ft LOAM: grey, sandy.
3– 9 ft CLAY: grey, medium-grained sandy.
9–12 ft CLAY: light grey, very sandy (fine-grained).
12–18 ft SANDSTONE: grey to red, clayey, decomposed.

BMP 192 (Grid Ref. 940203; Map Sheet 1)

0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+–12 ft SANDSTONE: red, coarse-grained, decomposed.

BMP 206 (Grid Ref. 926176; Map Sheet 1)

0–18 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 213 (Grid Ref. 906046; Map Sheet 1)

0–21 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 222 (Grid. Ref. 833063; Map Sheet 1)

0–18 ft SANDSTONE: red, fine- to medium-grained; decomposed.

BMP 227 (Grid Ref 814099; Map Sheet 1)

0– 6 ft SANDSTONE: red, medium-grained; hard, ferruginous, decomposed.
6–18 ft SANDSTONE: light grey to white, medium-grained, decomposed.

BMP 231 (Grid Ref. 825044; Map Sheet 1)

0–12 ft SANDSTONE: red, medium-grained; decomposed.

BMP 234 (Grid Ref. 789042; Map Sheet 1)

* 0– 3 ft CLAY: brown, plastic.
3– 6 ft CLAY: numerous small BASALT boulders and chips.

BMP 235 (Grid Ref. 788048; Map Sheet 1)

* 0– 3 ft CLAY: greenish plastic.
3–12 ft CLAY: green to brown, plastic; BASALT fragments increasing downwards.

BMP 237 (Grid Ref. 795053; Map Sheet 1)

0– 3+ft BASALT: greenish, decomposed
passing (3–6 ft) into
3+– 6 ft BASALT: hard.

BMP 239 (Grid Ref. 804051; Map Sheet 1)

0– 9 ft CLAY: red, very sandy.
9–18 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 248 (Grid Ref. 794022; Map Sheet 1)

0– 3 ft BASALT: decomposed; numerous large boulders.

BMP 251 (Grid Ref. 770045; Map Sheet 1)

* 0– 9 ft CLAY: red, hard; few small pebbles, 3–6 ft.
9–12 ft CLAY: red-brown.
12–18 ft CLAY: medium brown.
18–27 ft CLAY: blue-grey to red, plastic.

BMP 253 (Grid Ref. 750047; Map Sheet 1)

0–12 ft CLAY: red, hard; numerous granules.
12–18 ft SANDSTONE: yellow-brown to white to red, medium-grained; hard, decomposed.

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*Sample fired and proved unsuitable for the manufacture of bricks, tiles, pipes, common pottery, whiteware or pottery or for bloating.

APPENDIX—continued

BM.P. 255 (Grid Ref. 733041; Map Sheet 1)
0–18 ft SANDSTONE: brown to red, medium-grained, decomposed.

BMP 256 (Grid Ref. 732035; Map Sheet 1)
0– 9 ft BASALT: decomposed with partly decomposed fragments.

BMP 257 (Grid Ref. 742033; Map Sheet 1)
0– 9 ft SANDSTONE: red, medium-grained, decomposed.
9–12 ft SANDSTONE: red to yellow-brown, medium-grained, decomposed.
12–18 ft SANDSTONE: yellow-brown to grey, medium-grained, decomposed.

BMP 258 (Grid Ref. 754035; Map Sheet 1)
0– 3 ft SANDSTONE: red, hard, ferruginous; pebbly.

BMP 260 (Grid Ref. 747016; Map Sheet 1)
0– 3 ft CLAY: brown to black, plastic.
3– 6 ft BASALT: decomposed; numerous hard fresh pebbles.

BMP 261 (Grid Ref. 747020; Map Sheet 1)
0–12 ft SANDSTONE: red, medium-grained, decomposed; yellowish towards bottom.
12–18 ft SANDSTONE: light brown, decomposed.

BMP 263 (Grid Ref. 751028; Map Sheet 1)
0– 3 ft SANDSTONE: red, ferruginous, hard; decomposed at top; numerous hard red ironstone nodules.

BMP 264 (Grid Ref. 755011; Map Sheet 1)
0– 3+ ft LOAM: light brown, sandy
passing (3–6 ft) into
3+–12 ft SANDSTONE: red, fine- to medium-grained, decomposed.
12–15 ft CLAY: light grey, plastic.
15–18 ft CLAY: light red, sandy.
Remarks: Water (18 ft).

BMP 265 (Grid Ref. 758019; Map Sheet 1)
0– 6 ft SAND: light grey, fine-grained.
6–18 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 266 (Grid Ref. 763008; Map Sheet 1)
0–12 ft SANDSTONE: red, medium-grained, decomposed.
12–15 ft SANDSTONE: light grey and red, decomposed.

BMP 267 (Grid Ref. 772018; Map Sheet 1)
0– 0+ ft LOAM: grey-brown, sandy
passing (0–3 ft) into
0+–18 ft SANDSTONE: red, medium-grained, decomposed, clayey; numerous red hard rounded sandstone pebbles, 15–18 ft.

BMP 273 (Grid Ref. 754052; Map Sheet 1)
0– 3 ft LOAM: sandy.
3–15 ft SANDSTONE: red, hard, clayey; decomposed.

BMP 274 (Grid Ref. 736059; Map Sheet 1)
0– 3 ft LOAM: sandy.
3–15 ft SANDSTONE: red, decomposed.

BMP 276 (Grid Ref. 739076; Map Sheet 1)
0– 3 ft LOAM: yellow, sandy.
3–12 ft SANDSTONE: red, decomposed.

BMP 277 (Grid Ref. 750077; Map Sheet 1)
0– 3 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 278 (Grid Ref. 756078; Map Sheet 1)
0– 6 ft SANDSTONE: red, very hard, ferruginous.

BMP 279 (Grid Ref. 740085; Map Sheet 1)
0– 3 ft LOAM: yellow to red-brown, sandy (fine-grained).
3–15 ft SANDSTONE: red to red-brown, fine- to medium-grained, decomposed; hard.

BMP 281 (Grid Ref. 750090; Map Sheet 1)
0– 9+ ft SANDSTONE: light grey, medium-grained, decomposed
passing (9–12 ft) into
9+–12 ft SANDSTONE: red.

BMP 282 (Grid Ref. 745098; Map Sheet 1)
0–12 ft SANDSTONE: light grey, medium-grained, decomposed; brownish in part

BMP 284 (Grid Ref. 773094; Map Sheet 1)
0–15 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.
15–18 ft SANDSTONE: grey to yellow-brown, decomposed.

BMP 285 (Grid Ref. 763083; Map Sheet 1)
0– 6 ft SANDSTONE: red, medium-grained, decomposed.
6–15 ft SANDSTONE: light grey to white, fine- to medium-grained, decomposed; numerous small quartz pebbles, 9–15 ft.
15–21 ft CLAY: light grey, plastic; sandy in part, 18–21 ft.
21–24 ft SANDSTONE: light grey, decomposed.
24–30 ft SANDSTONE: mustard yellow, medium-grained, decomposed.

BMP 291 (Grid Ref. 726056; Map Sheet 1)
0–24 ft SANDSTONE: red, medium-grained, decomposed.
Remarks: Water (24 ft).

BMP 293 (Grid Ref. 705059; Map Sheet 1)
0–12 ft BASALT: decomposed.

BMP 295 (Grid Ref. 706066; Map Sheet 1)
0– 3 ft LOAM: red and grey, sandy.
3– 6 ft SANDSTONE: red, medium-grained, decomposed.
6–15 ft SANDSTONE: yellow-brown, medium-grained; numerous quartz pebbles.
15–18+ ft SANDSTONE: light grey, very fine-grained, decomposed
passing (18–21 ft) into
18+–21 ft CLAY: light grey, plastic.
21–24 ft SANDSTONE: light grey, very fine-grained, decomposed.

BMP 297 (Grid Ref. 695044; Map Sheet 1)
0–15 ft CLAY: greenish-brown; numerous nodules of fresh BASALT and some quartz; calcareous nodules, 9–12 ft.

APPENDIX—continued

BMP 299 (Grid Ref. 710038; Map Sheet 1)
0–12 ft CLAY: green to brown; with numerous rounded chips of altered BASALT.

BMP 300 (Grid Ref. 718042; Map Sheet 1)
0–12 ft CLAY: green to brown, sandy; with kernels of BASALT.

BMP 301 (Grid Kef. 725035; Map Sheet 1)
0–12 ft CLAY: brown; with altered BASALT chips.

BMP 302 (Grid Ref. 720050; Map Sheet 1)
0–12 ft BASALT: decomposed.

BMP 305 (Grid Ref. 800104; Map Sheet 1)
0–12 ft SANDSTONE: light grey to reddish, fine- to medium-grained, decomposed; clayey in part, 9–12 ft.
12–18 ft SANDSTONE: light grey, fine-grained, decomposed.
18–24 ft SANDSTONE: light grey to reddish, fine-grained, decomposed; numerous small pebbles.

BMP 306 (Grid Ref. 751007; Map Sheet 1)
0– 6 ft BASALT: greenish, sandy, decomposed; numerous pebbles.

BMP 307 (Grid Ref. 750003; Map Sheet 1)
0–12 ft BASALT: greenish, sandy, decomposed.

BMP 308 (Grid Ref. 725028; Map Sheet 1)
0–12 ft BASALT: decomposed (greenish clayey material).

BMP 314 (Grid Ref. 693017; Map Sheet 1)
0– 9 ft BASALT: decomposed.

BMP 315 (Grid Ref. 683027; Map Sheet 1)
0–15 ft SANDSTONE: light grey to pink, fine- to medium-grained, decomposed; reddish in part, 12–15 ft.

BMP 316 (Grid Ref. 752997; Map Sheet 1)
0–0+ ft LOAM: grey, sandy
passing (0–3 ft) into
0+9 ft CLAY: red-brown, plastic.
9–12 ft SANDSTONE: yellow-brown, fine-grained, decomposed; few ironstone nodules.
12–18 ft SANDSTONE: red, fine- to medium grained, decomposed, clayey; fine-grained, 15–18 ft.
18–21 ft SANDSTONE and SHALE and SILTSTONE: dark red, fine-grained, decomposed; light grey interbeds.
21–24 ft SANDSTONE and CLAY: red-brown; red-grey interbeds.
24–27+ ft SANDSTONE and CLAY: red-brown; light grey plastic interbeds
passing (27–30 ft) into
27+–30 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 319 (Grid Ref. 649054; Map Sheet 1)
0–12 ft SANDSTONE: red to yellow-brown, fine- to medium-grained, decomposed.

BMP 320 (Grid Ref. 694029; Map Sheet 1)
0–6 ft SANDSTONE: red, medium- to coarse-grained, decomposed.

BMP 322 (Grid Ref. 679062; Map Sheet 1)
0–12 ft SANDSTONE: red, medium-grained; numerous hard red ironstone nodules in part.
12–15 ft SANDSTONE: red and light grey, fine-grained, decomposed.
15–18 ft SANDSTONE: red and grey, fine- to medium-grained, decomposed.

BMP 323 (Grid Ref. 684031; Map Sheet 1)
0– 3 ft LOAM: grey, sandy.
3– 6 ft SILT: red; very fine ferruginous nodules decomposed basalt.
6– 9 ft BASALT: greenish, decomposed; brown to red silty interbed.
9–12 ft BASALT: yellow-green, decomposed.
12–21+ ft BASALT: sandy-looking; numerous decomposed basalt nodules
passing (21–24 ft) into
21+–24 ft CLAY: red-brown.
24–27 ft CLAY: green to brown, plastic.
27–30 ft CLAY: light yellow-brown.
30–33 ft CLAY: medium brown, plastic, basaltic in part.
33–36 ft CLAY: light to medium brown, plastic.

BMP 324 (Grid Ref. 660063; Map Sheet 1)
*0– 9 ft CLAY: dark brown, plastic.
*9–15 ft CLAY: light yellow-brown, plastic; numerous gypsum crystals.
*15–18 ft CLAY: dark green, plastic.
*18–30 ft SHALE: dark green.

BMP 327 (Grid Ref. 744117; Map Sheet 1)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+–12 ft SANDSTONE: light grey to red, medium-grained; decomposed.

BMP 330 (Grid Ref. 779126; Map Sheet 1)
0– 6 ft SANDSTONE: light grey, fine-grained, decomposed.
6– 9 ft SANDSTONE: grey to brown, fine-grained, decomposed.
9–12 ft SHALE: medium brown, soft; silty in part.
12–15 ft SILTSTONE: light grey, micaceous; decomposed.
15–18 ft SANDSTONE: grey to reddish, fine-grained; decomposed.
18–24 ft SHALE: brown, soft.

BMP 332 (Grid Ref. 772118; Map Sheet 1)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 3 ft CLAY.
3– 9 ft CLAY: light grey, plastic.
9–24 ft SANDSTONE: light grey to red, medium-grained, decomposed.

BMP 334 (Grid Ref. 788136; Map Sheet 1)
0– 0+ ft LOAM: sandy
passing (0–3 ft) into
0+– 6 ft CLAY: grey-brown, plastic.
6– 6+ ft QUARTZITE: boulder.

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*Sample fired and proved unsuitable for the manufacture of bricks, tiles, pipes, common pottery, whiteware or pottery or for bloating.

APPENDIX—continued

BMP 337 (Grid Ref. 752162; Map Sheet 1)
0–12 ft SANDSTONE: light grey; fine-grained; decomposed.

BMP 338 (Grid Ref. 751152; Map Sheet 1)
0– 9 ft CLAY: red; numerous sand grains and granules; very hard at bottom.

BMP 340 (Grid Ref. 797182; Map Sheet 1)
0– 0+ ft LOAM
passing (0–3 ft) into
0+– 3+ ft SANDSTONE: light brown, medium- to coarse-grained
passing (3–6 ft) into
3+– 6 ft GRAVEL: coarse.

BMP 344 (Grid Ref. 787210; Map Sheet 3)
0–12 ft SANDSTONE: medium-grained, decomposed; numerous small ironstone nodules towards bottom.
12–15+ ft SANDSTONE: red-brown; medium-grained
passing (15–18 ft) into
15+–18 ft SANDSTONE: medium-grained; light grey; decomposed.

BMP 346 (Grid Ref. 831204; Map Sheet 3)
0– 6 ft GRAVEL and SANDSTONE: hard.

BMP 347 (Grid Ref. 801219; Map Sheet 3)
0– 3 ft CLAY: brown; very sandy (coarse-grained).
3–12 ft CONGLOMERATE: numerous milky quartz pebbles up to 1 in.
12–18 ft SHALE: grey to greenish; fairly hard.
18–24 ft SANDSTONE: greenish; fairly hard, laminated.

BMP 355 (Grid Ref. 869317; Map Sheet 3)
0– 3 ft LOAM: yellow-brown, sandy (fine-grained).
3– 9 ft SANDSTONE: red, fine-grained, decomposed; few hard nodules.
9–15 ft CLAY: light grey and red, sandy.
15–18 ft CLAY: red, sandy; numerous hard red ferruginous sandstone nodules.

BMP 357 (Grid Ref. 874308; Map Sheet 3)
0– 3 ft LOAM: sandy.
3– 3+ ft CLAY: light grey
passing (3–6 ft) into
3+– 9+ ft SANDSTONE: grey and red, fine-grained, decomposed
passing (9–12 ft) into
9+–18 ft SHALE: grey to brown, hard.

BMP 359 (Grid Ref. 866306; Map Sheet 3)
0– 3 ft LOAM: yellow, sandy.
3–18 ft SANDSTONE: light grey to reddish, fine-grained, decomposed.

BMP 361 (Grid Ref. 879291; Map Sheet 3)
0–18 ft SANDSTONE: light grey, fine-grained, decomposed.

BMP 362 (Grid Ref. 889307; Map Sheet 3)
0– 3 ft LOAM: light grey, fine-grained, sandy.
3–12 ft CLAY: grey and red, very sandy.
12–18 ft SANDSTONE: light grey, fine-grained, decomposed..

BMP 363 (Grid Ref. 895315; Map Sheet 3)
0– 3 ft LOAM: grey, sandy.
3– 6 ft CLAY: grey to brown, plastic.
6–12 ft SANDSTONE: grey and red, fine-grained, decomposed.
12–15 ft CLAY: grey, red and brown; sandy in part.
15–18 ft CLAY: grey and red, sandy.

BMP 364 (Grid Ref. 899306; Map Sheet 3)
0– 3 ft LOAM: grey, sandy.
3–12 ft SANDSTONE: red, medium-grained, decomposed; clayey.
12–21 ft SANDSTONE: light grey, medium-grained, decomposed.

BMP 365 (Grid Ref. 921304; Map Sheet 3)
0– 3 ft LOAM: sandy.
3– 6 ft CLAY: grey and brown, very sandy.
6– 9 ft CLAY: medium grey, plastic; very sandy.
9–12 ft SANDSTONE: light grey, medium-grained, decomposed.
* 12–24 ft CLAY: light grey and red, plastic; mainly red, 21-24 ft.
24–30 ft CLAY: light grey to brown, plastic.

BMP 373 (Grid Ref. 960263; Map Sheet 3)
0– 3 ft LOAM: light grey, sandy.
3– 6 ft CLAY: brown, very sandy.
6–12 ft SANDSTONE: light grey, fine-grained, decomposed; few pebbles, 9–12 ft.
12–15 ft SANDSTONE: light grey, medium- to coarse-grained.
15–18 ft CLAY: light to medium grey, very sandy.

BMP 374 (Grid Ref. 959253; Map Sheet 3)
0– 3 ft SANDSTONE: red, medium-grained.
3– 6 ft CONGLOMERATE and SANDSTONE: red, hard.

BMP 375 (Grid Ref. 961245; Map Sheet 3)
0– 3 ft LOAM: sandy.
3– 9 ft SANDSTONE: red, coarse-grained, hard, decomposed; numerous granules, 3–6 ft; small pebbles, 6–9 ft.
9–18 ft BASALT: decomposed.

BMP 376 (Grid Ref. 963235; Map Sheet 3)
0– 9 ft BASALT: decomposed; with less decomposed nodules.

BMP 378 (Grid Ref. 974231; Map Sheet 3)
0– 6 ft BASALT: decomposed; less decomposed nodules, 3–6 ft.

BMP 379 (Grid Ref. 980236; Map Sheet 3)
0– 3 ft CLAY: with numerous hard red ironstone nodules.
3– 6 ft BASALT: decomposed, yellow-brown.

BMP 380 (Grid Ref. 988229; Map Sheet 3)
0– 9 ft BASALT: decomposed.
9–12 ft CLAY: red, plastic; numerous waxy fragments.
12–15 ft CLAY: brown, plastic; numerous waxy fragments.
15–18 ft BASALT: decomposed.

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APPENDIX—continued

BMP 381 (Grid Ref. 983224; Map Sheet 3)
0– 3 ft LOAM: yellow, sandy.
3–12 ft SANDSTONE: red, medium-grained, decomposed; clayey, very hard.

BMP 382 (Grid Ref. 970243; Map Sheet 3)
0– 3 ft LOAM: sandy.
3– 6 ft CLAY: brown, sandy.
6– 9 ft CLAY: red and grey, very sandy.
9–12 ft SANDSTONE: brown, decomposed.
12–21 ft GRAVEL: brown; matrix decomposed.

BMP 409 (Grid Ref. 574633; Map Sheet 5)
0–12+ ft CLAY: red, hard; numerous granules and few quartz pebbles below 9 ft passing (12–15 ft) into
12+–15 ft SANDSTONE: red, fine-grained.

BMP 411 (Grid Ref. 583624; Map Sheet 5)
0–12 ft CLAY: red, hard.

BMP 414 (Grid Ref. 569615; Map Sheet 5)
0– 9 ft CLAY: light brown, very sandy (fine-grained).
9–12 ft CLAY: light grey, very sandy (fine- to medium-grained).
12–21 ft CLAY: red, very sandy (medium- to coarse-grained); few pebbles.

BMP 415 (Grid Ref. 566645; Map Sheet 5)
* 0– 6 ft CLAY: light to medium brown, plastic.
* 6– 9 ft CLAY: light grey-red, plastic.
* 9–18 ft CLAY: yellow-brown, plastic.
*18–30 ft CLAY: dark green, calcareous, plastic.

BMP 417 (Grid Ref. 578651; Map Sheet 5)
* 0–12 ft CLAY: dark chocolate brown, plastic.
* 12–18 ft CLAY: light to medium brown.
* 18–21+ ft CLAY: yellow-brown, plastic passing (21–24 ft) into
21+–30 ft CLAY: dark green, calcareous, plastic.

BMP 418 (Grid Ref. 576643; Map Sheet 5)
0–21 ft CLAY: light brown, plastic.
21–24 ft CLAY: dark chocolate brown, plastic.
24–30 ft CLAY: dark green, plastic.
Remarks: Water (30 ft).

BMP 419 (Grid Ref. 594631; Map Sheet 5)
* 0– 6 ft CLAY: dark chocolate brown, plastic.
* 6–15 ft CLAY: light grey-brown, plastic.
* 15–21 ft CLAY: yellow-brown, plastic.
21–30 ft CLAY: dark brown to dark green, plastic, calcareous.

BMP 420 (Grid Ref. 586639; Map Sheet 5)
0– 9 ft CLAY: dark chocolate, plastic.
9–15 ft CLAY: light brown, plastic.
15–24 ft CLAY: light yellow-brown, plastic.
24–27 ft CLAY: light yellow to greenish, plastic; carbonaceous.
27–39 ft CLAY: dark green, plastic, calcareous; numerous greenish shale fragments.
Remarks: Water (39 ft).

BMP 426 (Grid Ref. 571666; Map Sheet 5)
0– 9 ft CLAY: red, hard; numerous small granules.
9–15 ft CLAY: light grey, plastic.
15–18 ft CLAY: light grey-brown, plastic; numerous shale chips.
18–24 ft CLAY: red brown and grey, plastic; numerous shale chips.
Remarks: Water (24 ft).

BMP 427 (Grid Ref. 559645; Map Sheet 5)
0– 9 ft CLAY: medium to dark brown, plastic.
9–30 ft CLAY: light green, calcareous, plastic.
Remarks: Water (30 ft).

BMP 428 (Grid Ref. 557654; Map Sheet 5)
0– 6 ft CLAY: medium to dark brown, plastic; numerous fragments of basalt towards the bottom.
6–12 ft BASALT: decomposed.

BMP 429 (Grid Ref. 559658; Map Sheet 5)
0–12 ft CLAY: light green, whitish in part; calcareous, plastic.
12–15 ft SHALE: light green, calcareous.
15–18 ft CLAY: light green, calcareous, plastic.
Remarks: Water (18 ft).

BMP 430 (Grid Ref. 550670; Map Sheet 5)
0–18 ft BASALT: decomposed to brown clayey material; nodules of less decomposed basalt.

BMP 432 (Grid Ref. 528673; Map Sheet 5)
0– 9 ft SILT: dark brown; loamy.
9–21 ft SAND: coarse-grained; gravelly in part.
21–27+ ft GRAVEL passing (27–30 ft) into
27+–30 ft CLAY: dark grey, plastic.
Remarks: Water (30 ft).

BMP 433 (Grid. Ref. 539681; Map Sheet 5)
0– 9 ft SILT: brown; loamy.
9–12 ft SAND: coarse-grained; gravelly.
12–18 ft GRAVEL.
Remarks: Water (18 ft).

BMP 434 (Grid Ref. 553678; Map Sheet 5)
0–39 ft CLAY: dark green, calcareous, plastic.

BMP 435 (Grid Ref. 556684; Map Sheet 5)
0– 9 ft BASALT: dark brown, decomposed, clayey.

BMP 436 (Grid Ref. 562691; Map Sheet 5)
0– 3 ft BASALT: decomposed; very hard at bottom.

BMP 437 (Grid Ref. 543706; Map Sheet 5)
0– 9 ft BASALT: decomposed; hard at bottom.

BMP 438 (Grid Ref. 556705; Map Sheet 5)
0–15 ft BASALT: decomposed; very hard at bottom.

BMP 439 (Grid Ref. 569703; Map Sheet 5)
0– 6 ft CLAY: medium brown, plastic.
6– 9 ft CLAY: white, calcareous, plastic.
9–12 ft CLAY: green-brown, calcareous, plastic.
12–27 ft SHALE: medium green, calcareous.
27–30 ft CLAY: green, calcareous.
Remarks: Water (30 ft).

BMP 440 (Grid Ref. 558714; Map Sheet 5)
0– 6 ft CLAY: light brown, plastic, sandy.
6–12 ft CLAY: light brown to red, plastic, sandy.
12–18 ft BASALT: decomposed.

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APPENDIX—continued

BMP 441 (Grid Ref. 549716; Map Sheet 5)
0–15 ft BASALT: brown, decomposed.

BMP 442 (Grid Ref. 560726; Map Sheet 5)
0– 9 ft CLAY: medium grey to brown, plastic.
9–30 ft CLAY: light to medium brown and light grey, plastic, very sandy.

BMP 443 (Grid Ref. 549728; Map Sheet 5)
0– 3 ft SILT: brown.
3– 6 ft CLAY: grey-brown, very sandy.
6– 9 ft CLAY: red-brown, very sandy.
9–18 ft SAND: light grey, medium to coarse-grained, clayey; coarse-grained at bottom.
Remarks: Water (18 ft).

BMP 444 (Grid Ref. 564734; Map Sheet 5)
0– 3 ft SILT.
3–18 ft SAND: brown, fine-grained, silty.
18–21 ft SAND: light grey, fine-grained.

BMP 452 (Grid Ref. 590721; Map Sheet 5)
0–12 ft CLAY: red, plastic, sandy.
12–15 ft CLAY: light brown, plastic, very sandy.
15–27+ ft GRAVEL: numerous quartz and greenstone pebbles
passing (27–30 ft) into
27+–30 ft CLAY: dark brown.
Remarks: Water (27 ft).

BMP 455 (Grid Ref. 597698; Map Sheet 5)
0– 3+ ft SANDSTONE: light grey, coarse-grained, decomposed
passing (3–6 ft) into
3+– 6 ft CONGLOMERATE.

BMP 456 (Grid Ref. 585691; Map Sheet 5)
0–12 ft CLAY: blue-grey and red, plastic.
12–18 ft CLAY: yellow-green, plastic; numerous yellow-green waxy shale chips.
18–24 ft CLAY: dark green, plastic.
24–30 ft SHALE: medium to dark green.

BMP 461 (Grid Ref. 622667; Map Sheet 5)
0– 3 ft SAND: yellow-brown, medium-grained.
3–12 ft CLAY: light brown, very sandy.
12–15 ft SANDSTONE: dark green, medium-grained, decomposed, clayey in part.
15–18 ft CLAY: dark green, plastic.
18–24 ft CLAY: medium brown, plastic, very sandy.
Remarks: Water (24 ft).

BMP 462 (Grid Ref. 631671; Map Sheet 5)
0– 3+ ft LOAM: grey to red, sandy
passing (3–6 ft) into
3+–12 ft CLAY: blue-grey to brown, plastic, sandy.
12–18 ft CLAY: red to grey-brown, plastic, sandy.
18–24 ft CLAY: red-brown, plastic, sandy.

BMP 463 (Grid Ref. 623679; Map Sheet 5)
0–21 ft SANDSTONE: red and light grey to white, fine-grained, decomposed.
Remarks: Water (21 ft).

BMP 466 (Grid Ref. 635694; Map Sheet 5)
0– 9 ft SANDSTONE: light grey, fine-grained, decomposed.
9–15 ft SANDSTONE: medium brown, decomposed.
15–18 ft No recovery: very hard.
Remarks: Water (18 ft).

BMP 467 (Grid Ref. 626701; Map Sheet 5)
0– 6 ft SAND: light grey, fine- to medium-grained.
6–15 ft SANDSTONE: red, fine- to medium-grained, decomposed.
15–21 ft CLAY: red and grey, very sandy.
Remarks: Water (6–9 ft).

BMP 468 (Grid Ref. 613702; Map Sheet 5)
0– 6 ft SANDSTONE: red and light grey, medium- to coarse-grained, very hard.

BMP 469 (Grid Ref. 625715; Map Sheet 5)
0–15 ft CLAY: blue-grey, sandy.
15–18 ft CLAY: greenish-brown; numerous green waxy fragments.
18–21 ft CLAY: green; numerous waxy fragments and pebbles of decomposed BASALT.
21–27 ft CLAY: green; with BASALT pebbles.

BMP 470 (Grid Ref. 615716; Map Sheet 5)
0– 6 ft CLAY: grey to greenish, plastic.
6–12 ft GREENSTONE: decomposed; greenstone pebbles in chloritic matrix.

BMP 471 (Grid Ref. 608714; Map Sheet 5)
0–15 ft GREENSTONE: numerous chloritic schist pebbles in chloritic matrix.

BMP 472 (Grid Ref. 598703; Map Sheet 5)
0–12 ft GRAVEL: greenstone (dominant) and quartz pebbles in brown matrix.

BMP 474 (Grid Ref. 634715; Map Sheet 5)
0– 3 ft CLAY: red and brownish.
3– 6 ft CLAY: greenish.
6–12 ft CLAY: light to medium brown; numerous waxy fragments.
12–15 ft CLAY: light grey, plastic.
15–18 ft SANDSTONE: medium grey, fine- to medium-grained.
Remarks: Water (18 ft).

BMP 475 (Grid Ref. 646719; Map Sheet 5)
0– 3 ft LOAM: grey, sandy.
3– 9 ft CLAY: red and blue-grey, plastic.
9–18 ft CLAY: medium brown to greenish, plastic; numerous light yellow waxy chips (?=decomposed BASALT).
18–24 ft CLAY: red, plastic.

BMP 477 (Grid Ref. 640740; Map Sheet 5)
0– 9 ft SANDSTONE: red, medium-grained, decomposed.
9–15 ft SANDSTONE: light yellow, medium-grained, decomposed.
15–18 ft SANDSTONE: light grey to light yellow, medium-grained, decomposed.

BMP 478 (Grid Ref. 670718; Map Sheet 5)
0– 3 ft LOAM: grey, sandy.
3–12 ft CLAY: red and grey, sandy; micaceous in part.
12–24 ft SILTSTONE: light grey to brown, decomposed; micaceous in part.

APPENDIX—continued

BMP 485 (Grid Ref. 639664; Map Sheet 5)
0– 6 ft CLAY: light grey, plastic.
6– 9 ft GRAVEL: numerous angular quartz pebbles.
9–15+ ft CLAY: light grey to light brown, plastic, very sandy
passing (15–18 ft) into
15+–24 ft CLAY: green to yellow, plastic.
24–27 ft CLAY: green, plastic; few waxy fragments.

BMP 486 (Grid Ref. 638656; Map Sheet 5)
0– 3 ft LOAM: yellow-grey, sandy.
3– 6 ft CLAY: red, sandy.
6– 9 ft GRAVEL: angular quartz fragments.
9–12 ft CLAY: blue-grey, plastic.
12–15 ft CLAY: red-brown, plastic.
15–24 ft CLAY: light grey to light brown, plastic, sandy.

BMP 487 (Grid Ref. 635646; Map Sheet 5)
0– 3 ft LOAM: sandy.
3–15 ft SANDSTONE: red, ferruginous, medium-grained.

BMP 488 (Grid Ref. 621649; Map Sheet 5)
0– 3 ft LOAM: light grey, sandy.
3– 9 ft CLAY: light grey and brown, very sandy.
9–15+ ft SANDSTONE: light grey and red-brown, fine-grained, decomposed
passing (15–18 ft) into
15+–24 ft SANDSTONE: light grey, coarse-grained, decomposed.
Remarks: Water (15 ft).

BMP 490 (Grid Ref. 647650; Map Sheet 5)
0– 3 ft LOAM: sandy.
3–15 ft SANDSTONE: medium grey, fine-grained, decomposed; coarser-grained in part.
15–21 ft CLAY: red, very sandy.
21–27 ft CLAY: yellow-brown, very sandy.
Remarks: Water (18 ft).

BMP 491 (Grid Ref. 649658; Map Sheet 5)
0– 3 ft LOAM: grey and yellow, sandy.
3–12 ft SANDSTONE: red, fine- to medium-grained, decomposed.
12–15 ft SANDSTONE: light grey, medium-grained, decomposed.
15–18 ft SANDSTONE: light grey, coarse-grained; with few pebbles.

BMP 493 (Grid Ref. 660631; Map Sheet 5)
0– 6 ft BASALT: decomposed; numerous waxy fragments.

BMP 495 (Grid Ref. 666631; Map Sheet 5)
0– 6 ft CLAY: brown to greenish-yellow (=decomposed BASALT).

BMP 496 (Grid Ref. 659621; Map Sheet 5)
0– 3 ft SOIL: brown-black.
3– 6 ft CLAY: medium green, plastic, calcareous; numerous soft nodules.
6– 9 ft CLAY: green-white, calcareous.
9–15 ft CLAY: medium green, plastic, calcareous; numerous waxy fragments.
15–24 ft CLAY: light brown to greenish, calcareous; numerous waxy fragments.
} = decomposed BASALT

BMP 497 (Grid Ref. 645633; Map Sheet 5)
0– 9 ft CLAY: dark chocolate, plastic.
9–15 ft CLAY: brown to green, plastic, sandy.
15–24 ft CLAY: green, plastic.
} = decomposed BASALT
Remarks: Water (18 ft).

BMP 498 (Grid Ref. 627626; Map Sheet 5)
0–12 ft SANDSTONE: red, medium-grained; numerous small pebbles.

BMP 499 (Grid Ref. 629637; Map Sheet 5)
0– 6 ft CLAY: dark brown to red, plastic, numerous small pebbles.
6–12 ft CLAY: light grey to light brown, plastic.
12–15 ft CLAY: light brown, light grey and red.
15–18 ft CLAY: grey to yellow-brown, plastic.

BMP 500 (Grid Ref. 631628; Map Sheet 5)
0–12 ft CLAY: light to medium brown, plastic, sandy.
12–18 ft SANDSTONE: grey, fine-grained, decomposed.
18–21 ft SANDSTONE: fine- to coarse-grained, decomposed.
21–24 ft SANDSTONE: coarse-grained; with GRAVEL.
Remarks: Water (18 ft).

BMP 501 (Grid Ref. 602630; Map Sheet 5)
0–12 ft CLAY: light brown, plastic, sandy.
12–15 ft SANDSTONE: grey-brown, coarse-grained, pebbly.
15–18 ft GRAVEL.
18–21 ft CLAY: brown, very sandy; few pebbles.
21–24 ft CLAY: medium grey, very sandy, plastic.

BMP 502 (Grid Ref. 609640; Map Sheet 5)
0–12 ft CLAY: light to medium brown, plastic, very sandy.
12–18 ft SANDSTONE: medium grey, medium-grained, plastic, decomposed.
18–24 ft GRAVEL and CLAY.

BMP 503 (Grid Ref. 602640; Map Sheet 5)
* 0–12 ft CLAY: grey-brown, plastic.
* 12–21 ft CLAY: light to medium brown, plastic.
21–24 ft CLAY: yellow-brown, plastic.
* 24–27+ ft CLAY: light to medium brown, plastic
passing (27–30 ft) into
* 27+–36 ft CLAY: dark green, calcareous, plastic.

BMP 504 (Grid Ref. 669618; Map Sheet 5)
* 0– 9 ft CLAY: light to medium brown, plastic.
* 9–21 ft CLAY: light brown, plastic.
21–30 ft CLAY: light yellow-brown, plastic.
30–33 ft CLAY: dark green, plastic, slightly calcareous.

BMP 505 (Grid Ref. 688625; Map Sheet 5)
0– 6 ft CLAY: dark brown, plastic.
6–12 ft CLAY: red-brown, plastic.
12–15 ft CLAY: brown to yellow to greenish, plastic.
15–24 ft CLAY: light yellow-brown, plastic, calcareous.
24–30 ft CLAY: dark green, plastic, calcareous; numerous calcite crystals.
Remarks: Water (30 ft).

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*Sample fired and proved unsuitable for the manufacture of bricks, tiles, pipes, common pottery, whiteware or pottery or for bloating.

APPENDIX—continued

BMP 506 (Grid Ref. 696631; Map Sheet 5)
0– 3 ft CLAY: dark brown.
3– 6 ft CLAY: dark yellow-brown, sandy.
6–12 ft CLAY: light grey to brown, plastic.
12–18 ft CLAY: light yellow-brown, plastic.
*18–21 ft CLAY: medium brown, plastic.
21–24 ft CLAY: dark chocolate, plastic.
24–27 ft CLAY: dark green, plastic.
Remarks: Water (27 ft).

BMP 507 (Grid Ref. 705620; Map Sheet 5)
0– 9 ft CLAY: yellow-brown to red-brown, plastic.
9–12 ft CLAY: blue-grey, plastic; numerous small granules of quartz.
12–15 ft CLAY: chocolate, plastic.
15–18 ft CLAY: blue-grey to brown, plastic.
18–21 ft CLAY: light grey to brown, plastic.
21–24 ft CLAY: light green, plastic; white, chalky in part (gypsum).

BMP 508 (Grid Ref. 696618; Map Sheet 5)
0– 9 ft CLAY: light to medium brown, plastic.
9–15 ft CLAY: dark chocolate to red-brown, plastic.
*15–24 ft CLAY: light green and red, plastic; few ironstone nodules.

BMP 509 (Grid Ref. 709613; Map Sheet 5)
0– 9 ft SAND: medium brown, medium-grained.
9–15 ft CLAY: grey and red to green, plastic.

BMP 510 (Grid Ref. 715605; Map Sheet 5)
0– 6 ft CLAY: yellow-brown, plastic.
6–15 ft CLAY: yellow-brown to grey, plastic.
15–18 ft CLAY: blue-grey, plastic.
*18–24 ft CLAY: medium grey, plastic.
Remarks: Water (24 ft).

BMP 512 (Grid Ref. 738609; Map Sheet 5)
0– 6 ft SAND: red-brown, fine- to medium-grained.
6–18 ft CLAY: blue-grey, plastic; few small ironstone pebbles.
Remarks: Water (18 ft).

BMP 513 (Grid Ref. 568582; Map Sheet 5)
0–12 ft CLAY: light grey and red, plastic.
12–21 ft CLAY: yellow and red-brown; few nodules.
21–24 ft CLAY: red-brown, plastic.

BMP 515 (Grid Ref. 538584; Map Sheet 5)
0–18 ft SANDSTONE: red, very fine-grained.

BMP 516 (Grid Ref. 646584; Map Sheet 5)
0–18 ft CLAY: yellow-brown, plastic.

BMP 519 (Grid Ref. 662554; Map Sheet 5)
0– 3 ft LOAM: grey, sandy.
3–12 ft CLAY: medium brown, plastic, very sandy.
12–24 ft SANDSTONE: medium grey, fine- to medium-grained; few pebbles.
Remarks: Water (24 ft).

BMP 520 (Grid Ref. 680569; Map Sheet 5)
0– 3 ft LOAM: light grey, sandy.
3–12 ft CLAY: grey-brown, plastic, very sandy.
12–18 ft CLAY: red-brown, plastic, very sandy; numerous small pebbles.
18–21+ ft SANDSTONE: medium grey, medium-grained
passing (21–24 ft) into
21+–24 ft CLAY: grey-green.
Remarks: Water (24 ft).

BMP 521 (Grid Ref. 623605; Map Sheet 5)
0– 6 ft CLAY: dark chocolate brown, plastic.
6–12 ft CLAY: light grey and red, plastic.
12–18 ft CLAY: grey-brown to reddish, plastic.
18–21+ ft CLAY: yellow brown, plastic
passing (21–24 ft) into
21+–24 ft CLAY: dark green, plastic.

BMP 531 (Grid Ref. 673774; Map Sheet 5)
0–18 ft SANDSTONE: yellow-brown, medium- to coarse-grained.

BMP 539 (Grid Ref. 634011; Map Sheet 1)
0– 9 ft CLAY: red, sandy.
9–18 ft CLAY: yellow-brown, sandy; numerous hard nodules.
18–24 ft SANDSTONE: light grey, fine-grained, hard.

BMP 540 (Grid Ref. 634003; Map Sheet 1)
0– 3 ft CLAY: red and brown, plastic.
3– 6 ft SHALE: light grey and light brown, hard.
6–21 ft SANDSTONE: light grey and red, medium-grained, decomposed.
21–24 ft CLAY: blue-grey, plastic; carbonaceous in part.
24–30 ft CLAY: light grey to medium brown, plastic.

BMP 541 (Grid Ref. 594008; Map Sheet 1)
0– 6 ft SILTSTONE: grey to medium brown, decomposed.
6–18 ft SANDSTONE: light grey to yellow-brown, fine-grained, decomposed.
Remarks: Water (18 ft).

BMP 542 (Grid Ref. 595018; Map Sheet 1)
0–15 ft CLAY: medium brown, plastic, very sandy.
15–30 ft SANDSTONE: light grey to yellow-brown, medium-grained, decomposed.

BMP 545 (Grid Ref. 742676; Map Sheet 5)
0– 6 ft SANDSTONE: light grey, coarse-grained.
6–12 ft SHALE: grey, carbonaceous, silty; few small pebbles.
12–15+ ft SANDSTONE: light grey, coarse-grained
passing (15–18 ft) into
15+–24+ ft CONGLOMERATE
passing (24–27 ft) into
24+–27 ft SANDSTONE: fine-grained.
Remarks: Water (27 ft).

BMP 546 (Grid Ref. 742676; Map Sheet 5)
0– 9 ft CONGLOMERATE: hard, light brown.
9–12 ft SANDSTONE: light grey, medium- to coarse-grained; numerous pebbles.
12–15 ft SANDSTONE: light grey and red, fine- to medium-grained; few pebbles.
15–21 ft SHALE: dark grey to dark brown, soft; few pebbles; silty in part, 18–21 ft.
21–24 ft SILTSTONE: light grey to brown, decomposed.
24–27 ft CLAY: red-brown, plastic; sandy in part.
27–30 ft CLAY: yellow-brown, plastic; sandy (coarse-grained) downwards.
Remarks: Water (24 ft).

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APPENDIX—continued

BMP 547 (Grid Ref. 668706; Map Sheet 5)
- 0– 3 ft CLAY: greenish-grey, plastic; numerous light yellow specks.
- 3– 6 ft CLAY: red in part.
- 6– 9 ft CLAY: purplish-red in part; few chips red sandstone.
- 9–12 ft CLAY: purplish-red; sandy (fine-grained) in part.
- 12–21 ft SANDSTONE: light grey and red, very fine-grained, decomposed; micaceous, 18–21 ft.

BMP 572 (Grid Ref. 762583; Map Sheet 5)
- 0– 6 ft SOIL: red-brown, clayey.
- 6–12 ft CLAY: red, hard; numerous ironstone and hard fine-grained sandstone nodules.
- 12–18 ft CLAY: red and grey; few ironstone nodules.

BMP 573 (Grid Ref. 754592; Map Sheet 5)
- 0–18 ft CLAY: red, dry, hard; numerous sand grains.
- 18–24 ft CLAY: red and grey, dry, hard, sandy.
- 24–30 ft SANDSTONE: light grey and red; fine-grained, decomposed.

BMP 578 (Grid Ref. 907444; Map Sheet 3)
- 0–12 ft SANDSTONE: light grey and red, medium-grained, decomposed.

BMP 582 (Grid Ref. 776320; Map Sheet 3)
- 0– 9+ ft CLAY: red, dry; numerous granules, 0–3 ft; numerous quartzite pebbles below 3 ft passing (9–12 ft) into
- 9+–12 ft PHYLLITE: chlorite.

BMP 583 (Grid Ref. 781324; Map Sheet 3)
- 0– 9 ft SANDSTONE: light grey and yellow-brown, fine-grained, decomposed; clayey in part, 3–6 ft; few small pebbles, 6–9 ft.
- 9–12 ft SANDSTONE: yellow-brown, fine-grained, decomposed; few small pebbles.
- 12–24 ft SANDSTONE: light yellow, medium-grained, decomposed; numerous small quartzite pebbles up to 1in.

BMP 585 (Grid Ref. 795292; Map Sheet 3)
- 0–12 ft GRAVEL: red, quartzite.

BMP 589 (Grid Ref. 775280; Map Sheet 1)
- 0– 6 ft PHYLLITE: clorite.

BMP 593 (Grid Ref. 805274; Map Sheet 3)
- 0–12 ft PHYLLITE: chloritic; light brown, hard; few quartzitic pebbles

BMP 594 (Grid Ref. 781280; Map Sheet 3)
- 0–12 ft CLAY: light yellow-brown; sandy, 6–12 ft.
- 12–18 ft PHYLLITE: chloritic.

Remarks: Water (18 ft).

BMP 595 (Grid Ref. 772302; Map Sheet 3)
- 0–15 ft CLAY: medium brown, plastic; red in part; few ironstone nodules below 3 ft.
- 15–15+ ft CLAY: red; numerous white shaly fragments (= decomposed TUFF) passing (15–18 ft) into
- 15+–18 ft SANDSTONE: light grey, fine-grained, decomposed.

Remarks: Water (18 ft).

BMP 596 (Grid Ref. 809264; Map Sheet 3)
- 0– 9 ft PHYLLITE: green, altered, hard; with a few quartzite pebbles.

BMP 599 (Grid Ref. 771200; Map Sheet 1)
- 0–18 ft CLAY: blue-grey and red, plastic; few ironstone nodules and sand grains below 3 ft.

BMP 603 (Grid Ref. 767151; Map Sheet 1)
- 0– 9 ft CLAY: blue-grey and red; sandy, plastic.
- 9–12 ft SANDSTONE: grey and red, fine-grained; very hard.

BMP 604 (Grid Ref. 719112; Map Sheet 1)
- 0– 9 ft SANDSTONE: red, fine- to medium-grained; very hard.
- 9–18 ft SANDSTONE: light grey, medium-grained, decomposed; numerous small pebbles, 15–18 ft.

BMP 605 (Grid Ref. 717101; Map Sheet 1)
- 0– 9 ft SANDSTONE: red, very hard.
- 9–12 ft SANDSTONE: light grey, medium-grained.

BMP 608 (Grid Ref. 688119; Map Sheet 1)
- 0–12 ft SANDSTONE: yellow-brown, fine-grained, decomposed.
- 12–18 ft SANDSTONE: light grey to brown, fine-grained, decomposed.

BMP 609 (Grid Ref. 694144; Map Sheet 1)
- 0– 3 ft LOAM.
- 3–12 ft SANDSTONE: red-brown, fine-grained, decomposed.

Remarks: Water (12 ft).

BMP 610 (Grid Ref. 709142; Map Sheet 1)
- * 0– 6 ft SHALE: dark red, hard; few ironstone nodules.
- * 6–15 ft SHALE: deep red-brown, hard; numerous ironstone fragments.
- 15–18 ft CLAY: yellow-brown; numerous ironstone granules and small pebbles.

Remarks: Water (18 ft).

BMP 611 (Grid Ref. 710004; Map Sheet 1)
- 0–12 ft SANDSTONE: red and light grey, medium- to coarse-grained, decomposed.

BMP 614 (Grid Ref. 694016; Map Sheet 1)
- 0–24 ft BASALT: light green to brown, decomposed.
- 24–30 ft CLAY: yellow-brown, decomposed.

BMP 615 (Grid Ref. 692016; Map Sheet 1)
- 0– 3 ft CLAY: red, sandy; numerous ironstone nodules.
- 3– 6 ft SANDSTONE: reddish-grey, medium-grained; decomposed.

BMP 616 (Grid Ref. 692016; Map Sheet 1)
- 0– 3 ft CLAY: red, sandy; numerous ironstone nodules.
- 3– 6 ft SANDSTONE: red, medium-grained, decomposed.

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APPENDIX—continued

BMP 617 (Grid Ref. 692016; Map Sheet 1)
0– 3 ft CLAY: green to yellow-green, plastic.
3– 9 ft BASALT: decomposed.

BMP 626 (Grid Ref. 555006; Map Sheet 1)
0– 3 ft CLAY: red-brown, plastic, very sandy.
3–15 ft CLAY: grey-brown, plastic; sandy in part.
15–18 ft SAND: light grey, fine-grained.
Remarks: Water (18 ft).

BMP 627 (Grid Ref. 557015; Map Sheet 1)
0– 6 ft CLAY: brown, sandy.
6–18 ft SAND: light grey-brown, very fine-grained.
18–24 ft CLAY: yellow-brown, very sandy.
24–30 ft SAND: brown, fine-grained.

BMP 635 (Grid Ref. 553082; Map Sheet 1)
0– 9 ft BASALT: decomposed.

BMP 636 (Grid Ref. 567107; Map Sheet 1)
0– 3 ft CLAY: brown, plastic.
3– 9 ft BASALT: black, hard; decomposed in part.

BMP 637 (Grid Ref. 569120; Map Sheet 1)
0–15 ft CLAY: medium brown, plastic.
*15–18 ft CLAY: yellow-brown, plastic.
18–27 ft CLAY: medium to dark brown, plastic.
27–33 ft CLAY: dark brown to dark green, plastic.

BMP 638 (Grid Ref. 550122; Map Sheet 1)
0– 9 ft BASALT: decomposed in part.

BMP 644 (Grid Ref. 537109; Map Sheet 1)
0–12 ft CLAY: red, plastic, sandy.
12–18 ft CLAY: green-brown, plastic; numerous BASALT fragments.

BMP 646 (Grid Ref. 506058; Map Sheet 2)
0–12 ft CLAY: medium brown, silty.
12–18 ft SAND: light grey, fine-grained.
Remarks: Water (12 ft).

BMP 647 (Grid Ref. 514062; Map Sheet 2)
0– 6 ft CLAY: medium brown, plastic.
6–27 ft SAND: grey and brown, fine-grained.
Remarks: Water (18 ft).

BMP 650 (Grid Ref. 499047; Map Sheet 2)
0– 6 ft CLAY: red and grey, sandy.
6–12 ft CLAY: light grey, plastic.
12–18 ft SANDSTONE: light grey, fine-grained.

BMP 651 (Grid Ref. 516045; Map Sheet 2)
0– 6 ft SAND: yellow-brown, fine-grained.
* 6–27 ft SILTSTONE: light grey.
27–30 ft CLAY: medium brown, silty.

BMP 653 (Grid Ref. 504016; Map Sheet 2)
0– 3 ft LOAM: yellow-brown.
3–15 ft SANDSTONE: grey and red, coarse-grained, decomposed.
15–27 ft CLAY: red and grey, plastic.
27–30 ft SANDSTONE: light grey, fine-grained, decomposed.

BMP 654 (Grid Ref. 500000; Map Sheet 2)
0– 3 ft LOAM: yellow-brown.
3–12 ft CLAY: red and grey plastic; sandy in part.
12–18 ft CLAY: medium grey, silty.

BMP 655 (Grid Ref. 509994; Map Sheet 2)
0– 3 ft CLAY: grey and brown, silty.
3– 6 ft SILTSTONE: light grey.
6–12 ft SANDSTONE: yellow-brown, fine-grained.

BMP 657 (Grid Ref. 482966; Map Sheet 2)
0–15 ft SANDSTONE: grey-brown, fine- to medium-grained, decomposed.

BMP 658 (Grid Ref. 503964; Map Sheet 2)
0– 6 ft SANDSTONE: light grey, fine-grained; micaceous in part.

BMP 659 (Grid Ref. 498940; Map Sheet 2)
0– 6 ft SANDSTONE: light grey, fine-grained, decomposed, micaceous in part.
6–12 ft SANDSTONE: grey to yellow-brown, fine-grained, decomposed.

BMP 660 (Grid Ref. 496926; Map Sheet 2)
0– 6 ft LOAM and CLAY: red and grey, sandy.
6–12 ft SANDSTONE: red, fine-grained, decomposed.

BMP 661 (Grid Ref. 493910; Map Sheet 2)
0–12 ft SANDSTONE: grey, red and yellow-brown, fine-grained, decomposed.

BMP 662 (Grid Ref. 510902; Map Sheet 2)
0– 9 ft CLAY: red, sandy; few small pebbles.
9–12 ft SANDSTONE: light grey, fine-grained, decomposed.

BMP 664 (Grid Ref. 539893; Map Sheet 1)
0–12 ft SANDSTONE: light grey, fine-grained, decomposed.

BMP 666 (Grid Ref. 558923; Map Sheet 1)
0– 6 ft SANDSTONE: light grey, fine-grained.

BMP 670 (Grid Ref. 585984; Map Sheet 1)
0– 6 ft SILTSTONE: medium brown.
6–12 ft SANDSTONE: light grey, fine-grained, decomposed.
12–18 ft SANDSTONE: grey-brown, fine-grained, decomposed.
Remarks: Water (12 ft).

BMP 671 (Grid Ref. 552997; Map Sheet 1)
0–18 ft SAND: grey and brown, fine-grained.
18–24 ft SANDSTONE: medium grey, medium-grained, decomposed.
Remarks: Water (18 ft).

BMP 672 (Grid Ref. 539988; Map Sheet 1)
0–12 ft SANDSTONE: light grey, fine-grained, feldspathic.

BMP 673 (Grid Ref. 552973; Map Sheet 1)
0–18 ft CLAY: medium to dark brown, plastic, sandy.

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APPENDIX—continued

BMP 674 (Grid Ref. 558966; Map Sheet 1)
0–12 ft CLAY: medium brown, sandy.
12–24 ft SAND: yellow-brown, very fine-grained.
24–30 ft SAND: light grey, fine-grained, feldspathic.
Remarks: Water (24 ft).

BMP 675 (Grid Ref. 546965; Map Sheet 1)
0– 9 ft CLAY: medium to dark brown, plastic, sandy.
9–18 ft SAND: light grey and medium brown, fine-grained.
Remarks: Water (18 ft).

BMP 676 (Grid Ref. 535978; Map Sheet 1)
0– 9 ft SANDSTONE: medium brown and grey, medium- to coarse-grained; few small pebbles; decomposed.
9–12 ft SANDSTONE: light grey and red.

BMP 677 (Grid Ref. 532983; Map Sheet 1)
0– 9 ft SANDSTONE: grey-brown, medium-grained.

BMP 686 (Grid Ref. 462995; Map Sheet 2)
0–15 ft SANDSTONE: grey and red, fine-grained, decomposed.
15–21 ft SANDSTONE: red, fine-grained, decomposed.
21–24 ft SANDSTONE: light grey, fine-grained, decomposed.
24–27 ft SANDSTONE: yellow-brown, fine-grained.

BMP 687 (Grid Ref. 461005; Map Sheet 2)
0– 6 ft SANDSTONE: medium brown, fine-grained, decomposed.
6– 9 ft CLAY: light grey, very sandy.
9–15 ft SANDSTONE: grey-brown, fine-grained, decomposed.

BMP 688 (Grid Ref. 450998; Map Sheet 2)
0– 9 ft SANDSTONE: yellow-brown, fine-grained, decomposed.
9–15 ft SANDSTONE: light grey to brown, fine-grained, decomposed.
15–18 ft SANDSTONE: medium brown, medium- to coarse-grained.

BMP 689 (Grid Ref. 440002; Map Sheet 2)
0– 9 ft SANDSTONE: medium brown, very fine-grained; 6 in. nodular layer at top.
9–15 ft SANDSTONE: red-brown, medium-grained, decomposed.
15–18 ft SANDSTONE: yellow-brown to red, medium- to coarse-grained, hard.

BMP 690 (Grid Ref. 430003; Map Sheet 2)
0–12 ft SANDSTONE: light grey to brown, fine-grained.

BMP 691 (Grid Ref. 423998; Map Sheet 2)
0–15 ft SANDSTONE: light grey to brown, fine-grained, decomposed.
15–18 ft CLAY: light grey, very sandy.

BMP 692 (Grid Ref. 429993; Map Sheet 2)
0– 6 ft SANDSTONE: brown, fine-grained; few ironstone nodules.
6–12 ft SANDSTONE: red-brown, medium- to coarse-grained, decomposed.

BMP 693 (Grid Ref. 423967; Map Sheet 2)
0– 9 ft SANDSTONE: grey-brown, fine-grained.
9–12 ft SANDSTONE: red, fine-grained, decomposed.
12–21 ft SANDSTONE: grey to red, fine-grained, decomposed; very hard ferruginous sandstone at bottom.

BMP 694 (Grid Ref. 417982; Map Sheet 2)
0– 6 ft SANDSTONE: light grey to brown, fine-grained, decomposed.
6– 9 ft CLAY: red and grey, very sandy.
9–15 ft SANDSTONE: light grey and red, fine- to medium-grained, decomposed.

BMP 696 (Grid Ref. 403970; Map Sheet 2)
0– 9 ft CLAY: light to medium grey, very sandy.
9–12 ft SANDSTONE: medium grey, fine-grained, decomposed.

BMP 697 (Grid Ref. 396984; Map Sheet 2)
0–12 ft SANDSTONE: light grey, medium- to coarse-grained, decomposed.

BMP 698 (Grid Ref. 395012; Map Sheet 2)
0–12 ft SANDSTONE: grey-brown, coarse-grained.

BMP 699 (Grid Ref. 370025; Map Sheet 2)
0– 9 ft SANDSTONE: light grey to red, coarse-grained.

BMP 700 (Grid Ref. 412024; Map Sheet 2)
0–18 ft SANDSTONE: light grey and red, fine-grained, decomposed.

BMP 701 (Grid Ref. 420050; Map Sheet 2)
0– 9 ft CLAY: light grey, plastic, sandy.
9–18 ft SANDSTONE: brown, coarse-grained.

BMP 706 (Grid Ref. 494147; Map Sheet 2)
0–12 ft BASALT: decomposed.

BMP 707 (Grid Ref. 510144; Map Sheet 2)
0– 6 ft CLAY: dark brown, plastic, sandy.
6– 9 ft CLAY: light green and white, plastic, calcareous.
9–18 ft CLAY: light green, plastic.
18–21 ft CLAY: light green, calcareous in part.
21–27 ft CLAY: green-brown; numerous rock fragments.
Remarks: Water (21 ft).

BMP 708 (Grid Ref. 497160; Map Sheet 2)
0– 9 ft CLAY: grey and brown, plastic, sandy.
9–12 ft CLAY: light green, plastic.
12–15 ft CLAY: red, plastic; numerous small yellow shale chips.
15–18 ft CLAY: light green; numerous yellow shale fragments.
18–24 ft CLAY: yellow-brown, plastic.
24–27 ft CLAY: medium brown, plastic.

BMP 710 (Grid Ref. 568115; Map Sheet 1)
0– 3 ft CLAY: medium to dark brown.
3– 6 ft BASALT: decomposed.

APPENDIX—continued

BMP 711 (Grid Ref. 569118; Map Sheet 1)
0– 3 ft CLAY: dark brown, plastic.
3–12 ft CLAY: medium brown, plastic; numerous hard yellow fragments.
12–21 ft CLAY: medium brown; numerous calcareous and basaltic fragments.
21–27 ft CLAY: medium brown, plastic; numerous fragments.
Remarks: Water (21 ft).

BMP 712 (Grid Ref. 578114; Map Sheet 1)
0– 6 ft CLAY: dark and light brown, plastic.
6– 9 ft BASALT: decomposed in part.
Remarks: Water (9 ft).

BMP 713 (Grid Ref. 580120; Map Sheet 1)
0– 3 ft CLAY: dark brown, plastic.
3– 9 ft CLAY: light to medium brown; numerous white calcareous nodules; few small fragments of BASALT.
9–12 ft CLAY: brown-green; numerous calcareous and BASALT fragments.
12–15 ft CLAY: light brown; numerous hard fragments.
Remarks: Water (15 ft).

BMP 714 (Grid Ref. 541192; Map Sheet 1)
0–12 ft SANDSTONE: light grey to brown, medium- to coarse-grained; few pebbles up to 1 in.

BMP 717 (Grid Ref. 462168; Map Sheet 2)
0–15 ft CLAY: medium brown, plastic; very sandy.
15–18 ft SAND: brown, fine-grained.

BMP 718 (Grid Ref. 453167; Map Sheet 2)
0–15 ft CLAY: medium brown, plastic, very sandy.
15–30 ft SAND: medium brown, fine-grained.

BMP 720 (Grid Ref. 445186; Map Sheet 2)
0– 6 ft CLAY: red and brown, sandy.
6–12 ft SANDSTONE: medium brown, fine-grained, hard.

BMP 725 (Grid Ref. 193084; Map Sheet 2)
0– 3 ft CLAY: brown, very sandy.
3– 6 ft SANDSTONE: grey-brown, coarse-grained, very hard; few pebbles.

BMP 729 (Grid Ref. 209103; Map Sheet 2)
0– 6 ft CLAYEY SOIL: red, very sandy.

BMP 730 (Grid Ref. 221103; Map Sheet 2)
0– 6 ft CLAYEY SOIL: red; few boulders and small pebbles.

BMP 732 (Grid Ref. 216085; Map Sheet 2)
0– 6 ft CLAY: blue-grey and red; numerous granules and small pebbles; hard SHALE at bottom.

BMP 741 (Grid Ref. 235119; Map Sheet 2)
0– 3 ft CONGLOMERATE: very hard.

BMP 744 (Grid Ref. 237146; Map Sheet 2)
0–12 ft CLAY: medium brown, plastic; numerous pebbles up to 2 in. (subangular).
Remarks: Further penetration impossible. ?Boulder.

BMP 746 (Grid Ref. 218157; Map Sheet 2)
0– 6 ft CLAY: medium brown, plastic.
6–12 ft BASALT: hard, green-black.

BMP 748 (Grid Ref. 203152; Map Sheet 2)
0– 6 ft CLAY: dark red, plastic, sandy; hard.
6–12 ft CLAY: red-brown, very sandy (coarse-grained).
12–15 ft CONGLOMERATE: hard; numerous angular quartzite pebbles up to ¼ inch.

BMP 750 (Grid Ref. 195143; Map Sheet 2)
0– 6 ft CLAY: dark red, very sandy.
6–15 ft CLAY: grey and red, plastic, sandy.
15–18 ft CLAY: red, very sandy.
18–24 ft CLAY: light grey, very sandy.
24–30 ft CLAY: light grey, plastic.

BMP 751 (Grid Ref. 198148; Map Sheet 2)
0–27 ft BASALT: decomposed.

BMP 752 (Grid Ref. 199153; Map Sheet 2)
0–18 ft BASALT: decomposed.

BMP 754 (Grid Ref. 201168; Map Sheet 2)
0– 9 ft CLAY: medium brown, plastic; numerous small angular quartz pebbles.
9–21 ft CLAY: medium brown, plastic; numerous small pebbles.
21–27 ft CLAY: medium brown, numerous white specks.
27–30 ft SANDSTONE: medium brown, coarse-grained; few small pebbles.

BMP 755 (Grid Ref. 232120; Map Sheet 2)
0– 3 ft SANDSTONE: coarse-grained.
3–18 ft BASALT: decomposed.

BMP 756 (Grid Ref. 232120; Map Sheet 2)
0–18 ft SANDSTONE: light grey, coarse-grained.

BMP 757 (Grid Ref. 202175; Map Sheet 2)
0– 9 ft "METAMORPHICS": detritus.

BMP 758 (Grid Ref. 190183; Map Sheet 2)
0– 3 ft "METAMORPHICS": detritus.

BMP 759 (Grid Ref. 185173; Map Sheet 2)
0– 6 ft "METAMORPHICS".

BMP 760 (Grid Ref. 191173; Map Sheet 2)
0– 3 ft SHALE: green, altered.

BMP 761 (Grid Ref. 193174; Map Sheet 2)
0– 6 ft "METAMORPHICS".

BMP 762 (Grid Ref. 190172; Map Sheet 2)
0–15 ft BASALT: decomposed; numerous calcareous nodules.

BMP 766 (Grid Ref. 265102; Map Sheet 2)
0– 6 ft CLAY: yellow-brown, plastic, very sandy.
6–12 ft CLAY: medium brown, plastic, sandy.
12–21 ft CLAY: medium grey, plastic, very sandy.
21–24 ft SAND: red-brown, coarse-grained.

BMP 767 (Grid Ref. 283147; Map Sheet 2)
0– 6 ft SANDSTONE: light grey, coarse-grained; few small pebbles.

APPENDIX—continued

BMP 769 (Grid Ref. 277153; Map Sheet 2)
0– 6 ft SANDSTONE: grey to brown, medium-grained, decomposed.
6– 9 ft SANDSTONE: grey to brown, coarse-grained; numerous small pebbles.
9–15 ft SANDSTONE: grey to brown, medium-grained, decomposed.
15–24 ft SANDSTONE: light grey, fine-grained, decomposed.
24–30 ft SHALE: light brown.

BMP 771 (Grid Ref. 282157; Map Sheet 2)
0– 6 ft "SCHIST".

BMP 772 (Grid Ref. 282157; Map Sheet 2)
0–12 ft SANDSTONE: light brown, medium- to coarse-grained; numerous pebbles.

BMP 774 (Grid Ref. 370195; Map Sheet 2)
0–18 ft SANDSTONE: medium brown, fine-grained; numerous white specks.

BMP 775 (Grid Ref. 405187; Map Sheet 2)
0–12 ft CLAY: medium to dark brown, very sandy; numerous pebbles at bottom.
Remarks: Further penetration impossible. ?Boulder.

BMP 777 (Grid Ref. 408178; Map Sheet 2)
0–12 ft SANDSTONE: light grey, fine-grained, decomposed.
12–15 ft SANDSTONE: brown and red, coarse-grained.
15–18 ft CONGLOMERATE: pebbles up to 1 in.

BMP 778 (Grid Ref. 401170; Map Sheet 2)
0– 6 ft SANDSTONE: light grey, medium-grained.

BMP 779 (Grid Ref. 392154; Map Sheet 2)
0– 6 ft CLAY: light brown, plastic.
6–12 ft CLAY: grey to light brown, sandy.
12–18 ft SANDSTONE: light brown, very hard; ferruginous.

BMP 780 (Grid Ref. 390146; Map Sheet 2)
0–15 ft SANDSTONE: grey to light brown, fine-grained; numerous pink crystals; decomposed.

BMP 781 (Grid Ref. 390138; Map Sheet 2)
0–12 ft SANDSTONE: light grey, medium-grained, decomposed; numerous small pebbles up to 1 inch.

BMP 784 (Grid Ref. 353143; Map Sheet 2)
0– 6 ft SANDSTONE: light grey, medium- to coarse-grained.

BMP 787 (Grid Ref. 305150; Map Sheet 2)
0– 6 ft CLAY: brown; numerous angular pebbles.

Logs by: N. A. H. Simmonds

BMP 828 (Grid Ref. 851054; Map Sheet 1)
0– 3 ft CLAY: red and olive; pebbly, ferruginous.
3– 6 ft CLAY: red and white mottled; rare pebbles.
6–15 ft CLAY: white to light grey; some ironstone nodules, 12–15 ft
15–18 ft SANDSTONE: pale red-brown, clayey; pebbly.
18–24 ft SANDSTONE: medium brown, clayey; pebbly.
24–30 ft SANDSTONE: light grey, clayey; pebbly.
30–33 ft SANDSTONE: red-brown, clayey; pebbly.
33–42 ft SANDSTONE: medium brown, clayey; pebbly; becoming coarser towards bottom.
Remarks: Moist (21–24 ft).

BMP 829 (Grid Ref. 849054; Map Sheet 1)
0– 3+ ft SANDSTONE: olive, clayey passing (3–6 ft) into
3+– 6 ft CLAY: red-brown, sandy.
6– 9 ft CLAY: medium brown, sandy.
9–15 ft SANDSTONE: light grey, clayey.
15–21 ft SANDSTONE: red mottled, clayey.
21–33 ft CLAY: medium brown, sandy.
33–36 ft SAND: light to dark grey, clayey.

BMP 830 (Grid Ref. 846055; Map Sheet 1)
0– 3 ft LOAM: sandy, clayey.
3– 9 ft CLAY: light brown to red, plastic.
9–12 ft CLAY: grey to medium brown; medium-grained, sandy.
12–15 ft CLAY: light grey, fine-grained, sandy.
15–18 ft CLAY: light brown, medium-grained, sandy.
18–21 ft CLAY: grey, sandy (fine-grained) and grey, plastic.
21–30 ft SANDSTONE: clayey.

BMP 831 (Grid Ref. 844055; Map Sheet 1)
0– 6 ft SANDSTONE and SHALE: white, fine-grained.
6–15 ft SANDSTONE and SHALE: light brown, fine-grained; hard, 12–15 ft.

BMP 839 (Grid Ref. 398477; Map Sheet 4)
0– 3 ft LOAM: dark grey.
3– 6+ ft CLAY: dark grey, sandy, plastic passing (6–9 ft) into
6+– 9 ft SAND: light brown, clayey.
9–15 ft CLAY: light brown, sandy.
15–18 ft SAND: coarse-grained, slightly clayey.
Remarks: Water (18 ft).

BMP 840 (Grid Ref. 396478; Map Sheet 4)
0– 6 ft CLAY: light brown, sandy, plastic.
6– 9 ft SAND: brown, slightly clayey.
9–12 ft CLAY: grey, sandy.
12–15 ft SAND: light brown, clayey.

BMP 848 (Grid Ref. 393481; Map Sheet 4)
0– 3 ft LOAM: clayey.
3– 6 ft CLAY: dark grey to brown, sandy.
6–15 ft CLAY: light brown, sandy; with fragments of pink granite.
15–18 ft GRANITE: decomposed, clayey.

BMP 849 (Grid Ref. 388493; Map Sheet 4)
0– 3 ft LOAM: clayey.
3– 6 ft SILT.
6– 6+ ft CLAY: light brown, plastic passing (6–9 ft) into
6+– 9 ft SAND: light grey, clayey.
9–18 ft SAND and GRAVEL: clayey.
18–21 ft CLAY: dark brown, sandy.
21–24 ft CLAY: blue-grey to light brown, sandy.
24–27 ft CLAY: light grey; gravelly.
27–30 ft GRAVEL: light grey, clayey.
Remarks: Water (21 ft).

BMP 851 (Grid Ref. 380494; Map Sheet 4)
0– 3 ft LOAM: dark grey.
3– 6 ft LOAM: black, clayey.
6–12 ft SAND and GRAVEL: with 1 ft light grey to light brown plastic CLAY at base.
12–36 ft CLAY: light brown, sandy; with GRAVEL, 2–3 ft; blue-grey plastic sandy CLAY about 33 ft.
Remarks: Water (11 ft).

APPENDIX—continued

BMP 852 (Grid Ref. 380491; Map Sheet 4)
0– 9 ft LOAM: clayey.
9–12+ ft GRAVEL and SILT
passing (12–15 ft) into
12+–15+ ft CLAY: medium brown, sandy and gravelly
passing (15–18 ft) into
15+–18 ft GRAVEL and CLAY.

BMP 853 (Grid Ref. 378487; Map Sheet 4)
0–12 ft LOAM: light brown, sandy; gravelly, 6–9 ft.
12–14 ft SAND and GRAVEL: clayey.

BMP 856 (Grid Ref. 370490; Map Sheet 4)
0–15 ft SCHIST: decomposed; with light grey plastic CLAY.
15–18 ft SCHIST: hard.

BMP 857 (Grid Ref. 369488; Map Sheet 4)
0– 6 ft SOIL: black; gravelly, 3–6 ft.
6–12 ft LOAM: dark brown, sandy; very gravelly.

BMP 858 (Grid Ref. 345496; Map Sheet 4)
0– 6 ft SAND: light brown; clayey, gravelly.

BMP 859 (Grid Ref. 351489; Map Sheet 4)
0– 6 ft LOAM: dark brown; gravelly, 3–6 ft.
6– 9 ft GRAVEL.
9–15 ft CLAY: medium grey, sandy; with gravel.
15–18 ft SCHIST.

BMP 865 (Grid Ref. 328460; Map Sheet 4)
0– 3+ ft LOAM
passing (3–6 ft) into
3+– 6 ft SAND and GRAVEL: hard.

BMP 868 (Grid Ref. 360492; Map Sheet 4)
0– 3 ft LOAM: light brown.
3– 9+ ft CLAY: light brown, sericitic; sandy with some gravel, 6–9 ft
passing (9–12 ft) into
9+–12 ft SCHIST.

BMP 879 (Grid Ref. 353498; Map Sheet 4)
0– 3 ft LOAM: medium grey, sandy, clayey.
3– 9+ ft CLAY: red-brown, coarse-grained, sandy to light grey, plastic with some pebbles.
9+ ft SCHIST.

BMP 880 (Grid Ref. 348494; Map Sheet 4)
0– 6 ft LOAM: sandy, light brown.
6– 9 ft CLAY: sandy, light brown.
9–12 ft CLAY: very sandy, medium brown.
12–18 ft SAND: clayey, red-brown.

BMP 886 (Grid Ref. 789149; Map Sheet 1)
0–12 ft SANDSTONE: reddish-brown.

BMP 897 (Grid Ref. 907127; Map Sheet 1)
0– 3 ft LOAM: light brown, silty.
3– 6 ft CLAY: red-brown, sandy.
6– 9 ft CLAY: light grey and red-brown, sandy.
9–12 ft SAND: light grey, clayey.
12–18 ft SANDSTONE: red.

BMP 900 (Grid Ref. 963158; Map Sheet 1)
0– 3 ft SILT.
3– 6 ft CLAY: red-brown, silty; plastic when wet.
6–15+ ft CLAY: red, plastic when wet; slightly silty, 3–6 ft; few quartz pebbles, 12–15 ft
passing, (15–18 ft) into
15+–18 ft GRAVEL: clayey.

BMP 901 (Grid Ref. 953146; Map Sheet 1)
0– 3 ft SILT and CLAY.
3– 6 ft CLAY: light brown, dry, hard, silty.
6– 9 ft CLAY: light grey to light brown, silty.
9–12 ft CLAY: light grey, sandy (coarse-grained).
12–15+ ft CLAY: light red-brown, sandy
passing (15–18 ft) into
15+–21 ft CLAY: pinkish-brown and light grey; sandy and gravelly.

BMP 902 (Grid Ref. 884116; Map Sheet 1)
0– 3 ft LOAM: sandy.
3– 6 ft CLAY: light red and light grey, sandy (fine-grained).
6– 9 ft CLAY: light grey, sandy (fine-grained).
9–12 ft CLAY: light grey and light red, sandy (fine-grained).
12–15 ft CLAY: light grey, silty.
15–18 ft SAND: light brown and white, clayey.

BMP 903 (Grid Ref. 888123; Map Sheet 1)
0– 3 ft CLAY: sandy.
3– 6 ft SANDSTONE: clayey; with gravel.

BMP 904 (Grid Ref. 897114; Map Sheet 1)
0– 3 ft LOAM and CLAY: sandy.
3– 6 ft CLAY: pinkish-brown, sandy.
6– 9 ft CLAY: light brown, sandy.
9–12 ft CLAY: light grey, sandy.

BMP 909 (Grid Ref. 840115; Map Sheet 1)
0– 3 ft LOAM: red and greenish-brown, clayey.
3– 9+ ft CLAY: light grey and red-brown; slightly sandy, 3–6 ft; few ironstone pebbles, 6–9 ft
passing (9–12 ft) into
9+–12+ ft SHALE: light grey
passing (12–15 ft) into
12+–18 ft CLAY: red-brown, sandy; few ironstone nodules.

BMP 910 (Grid Ref. 861105; Map Sheet 1)
0– 3 ft LOAM.
3– 9 ft SHALE: light grey.
9–12 ft SANDSTONE: light pinkish-brown.

Log by: J. W. Laycock

BMP 911 (Grid Ref. 861101; Map Sheet 1)
0– 3 ft LOAM: red and black, clayey.
3– 6 ft CLAY: red-brown, hard, sandy.
6–27 ft CLAY: light grey to light brown, granular.
27–30 ft CLAY: light grey; plastic when wet; few ferruginous nodules.
30–42 ft CLAY: light grey and red-brown.

Logs by: N. A. H. Simmonds

BMP 912 (Grid Ref. 895240; Map Sheet 3)
0– 3 ft SILT.
3– 6 ft CLAY: light grey and light brown, hard.
6– 9 ft CLAY: light red to brown to greenish-grey.
9–12 ft CLAY: red-brown, sandy.
12–15 ft PHYLLITE.

APPENDIX—continued

BMP 913 (Grid Ref. 885242; Map Sheet 3)
0–12 ft PHYLLITE.

Logs by: J. W. Laycock

BMP 917 (Grid Ref. 818159; Map Sheet 1)
0–12 ft SANDSTONE: light grey to brown, fine-grained, weathered.

BMP 927 (Grid Ref. 880135; Map Sheet 1)
0–12 ft SANDSTONE: light grey, medium-grained; decomposed.

BMP 937 (Grid Ref. 780150; Map Sheet 1)
0– 6 ft SANDSTONE: red, fine- to medium-grained, decomposed.
6–18 ft SANDSTONE: light grey to red, medium-grained, decomposed; few hard, coarse-grained ferruginous sandstone bands, 6–12 ft; numerous small (⅛–1 in.) quartzite pebbles, 12–18 ft.

BMP 942 (Grid Ref. 774157; Map Sheet 1)
0– 3 ft LOAM: brown, sandy.
3– 9 ft CLAY: blue-grey and brown, sandy.
9–12 ft CLAY: yellow-brown, very sandy.
Remarks: Water (12 ft).

BMP 958 (Grid Ref. 754166; Map Sheet 1)
0–30 ft SANDSTONE: light grey to light brown, medium-grained, decomposed.

BMP 962 (Grid Ref. 926126; Map Sheet 1)
0– 3 ft LOAM: brown, sandy.
3– 9 ft CLAY: light grey and brown, plastic.
9–18 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

BMP 967 (Grid Ref. 919104; Map Sheet 1)
0–30 ft PHYLLITE: light green and light brown.

BMP 974 (Grid Ref. 837095; Map Sheet 1)
0–21 ft CLAY: deep red, sandy (medium-grained); few ironstone nodules, 3–9 ft.
21–36 ft SANDSTONE: light brown to light red, medium- to coarse-grained, decomposed.
36–42 ft SANDSTONE: light grey to brown, coarse-grained, decomposed.

BMP 975 (Grid Ref. 723015; Map Sheet 1)
0– 3 ft LOAM: yellow-brown, sandy.
3–15 ft SANDSTONE: red, medium-grained, decomposed.

BMP 976 (Grid Ref. 722007; Map Sheet 1)
0– 3+ ft SANDSTONE: light to medium brown, fine-grained, decomposed
passing (3–6 ft) into
3+– 6 ft SHALE: light grey, hard.
6–24 ft SANDSTONE: light to medium brown, fine-grained, decomposed.
24–42 ft CLAY: light to medium brown, plastic.

BMP 978 (Grid Ref. 713003; Map Sheet 1)
0– 3 ft CLAY: brown, sandy.
3– 9 ft CLAY: red-brown, sandy, plastic.
9–12 ft CLAY.
12–25 ft SANDSTONE: brown, medium- to coarse-grained, decomposed.

BMP 979 (Grid Ref. 718013; Map Sheet 1)
0– 3 ft CLAY: dark brown, plastic.
3– 9 ft CLAY: white and greenish, plastic.
9–21 ft CLAY: light green to brown, plastic.
21–24 ft CLAY: light brown, plastic; numerous light yellow shale fragments.
24–30 ft CLAY: medium brown, plastic; numerous shale fragments.

BMP 980 (Grid Ref. 672037; Map Sheet 1)
0–18 ft CLAY: red, very sandy (fine- to medium-grained).

BMP 981 (Grid Ref. 668038; Map Sheet 1)
0– 9 ft CLAY: red-brown, plastic, very sandy.
9–12 ft CLAY: red, plastic, very sandy.
12–18 ft CLAY: light grey to light brown, plastic.
18–24 ft SANDSTONE: red, medium-grained, decomposed.

BMP 982 (Grid Ref. 671034; Map Sheet 1)
0– 6 ft CLAY: light grey-brown.
6– 9 ft SHALE: light grey, very hard.

BMP 993 (Grid Ref. 545053; Map Sheet 1)
0–12 ft SANDSTONE: brown, fine- to medium-grained.
12–18 ft CLAY: medium brown, plastic.
18–30 ft SAND: medium brown, fine-grained.

BMP 1009 (Grid Ref. 959257; Map Sheet 3)
0– 3 ft LOAM: grey, sandy.
3– 6+ ft LOAM: yellow-brown, sandy; pebbly, 6–7 ft
passing (6–9 ft) into
6+– 9 ft CLAY: medium brown and grey, plastic.
9–24 ft CLAY: red, plastic.
24–30 ft CLAY: grey to brown, plastic.

BMP 1010 (Grid Ref. 960266; Map Sheet 3)
0– 6 ft LOAM: brown to grey, sandy.
6–15 ft CLAY: light grey to light brown, plastic; slightly sandy.
15–24 ft SAND: grey to brown, medium-grained.
Remarks: Water (18 ft).

BMP 1020 (Grid Ref. 969307; Map Sheet 3)
0– 6 ft LOAM: grey, sandy.
6–24 ft CLAY: light to medium brown, plastic, very sandy (coarse-grained); few pebbles, 15–24 ft.
24–30 ft CLAY: red to brown, plastic, sandy (coarse-grained); pebbly in part.
30–36 ft SANDSTONE: light grey, medium-grained, decomposed; few pebbles, 33–36 ft.

BMP 1021 (Grid Ref. 970315; Map Sheet 3)
0– 3 ft LOAM: grey, sandy.
3–15 ft CLAY: medium brown, red and light grey; very sandy (coarse-grained), few pebbles.
15–18 ft CLAY: light grey, very sandy (medium-grained).
18–30 ft CLAY: red, very sandy.
30–36 ft GRAVEL: up to 2 in.
Remarks: Water (21 ft).

BMP 1023 (Grid Ref. 972323; Map Sheet 3)
0– 3 ft GRAVEL: red; clayey matrix.
3– 9 ft SANDSTONE: light grey, medium-grained; gravelly in part.

APPENDIX—continued

BMP 1024 (Grid Ref. 980300; Map Sheet 3)
0–24 ft CLAY: brown to greenish; hard BASALT chips, 12–18 ft; reddish in part, 21–24 ft.
24–42 ft BASALT: decomposed.
42–48 ft BASALT: greenish, very hard, very calcareous in part.
Remarks: Water (6 ft).

BMP 1026 (Grid Ref. 981307; Map Sheet 3)
0–30 ft BASALT: decomposed.
Remarks: Water (30 ft).

BMP 1028 (Grid Ref. 965248; Map Sheet 3)
0– 3 ft LOAM: light brown, sandy.
3–15 ft SANDSTONE: red, medium-grained, decomposed.
15–21 ft CLAY: red-brown, very sandy (medium-grained); gravelly, 18–21 ft.
21–24 ft CLAY: red-brown, plastic.
24–30 ft CLAY: red, plastic.

BMP 1029 (Grid Ref. 953262; Map Sheet 3)
0– 9 ft CLAY: brown, sandy; few pebbles, 6–9 ft.
9–12 ft BASALT: decomposed.
12–13 ft SHALE: dark grey, slightly metamorphosed.
13–39 ft BASALT: yellow-green, decomposed; very hard at base.
Remarks: Water (39 ft).

BMP 1030 (Grid Ref. 946270; Map Sheet 3)
0–18 ft BASALT: decomposed.
18–30 ft BASALT: decomposed; brownish clay, with numerous greenish-yellow waxy chips.
30–36 ft BASALT: decomposed; numerous kernels of less decomposed basalt with green waxy inclusions.
36–42 ft BASALT: decomposed; brown CLAY with numerous soft green fragments.
42–51 ft BASALT: decomposed; brown clay with numerous hard basalt fragments.

BMP 1034 (Grid Ref. 929310; Map Sheet 3)
0– 9 ft LOAM: red, very sandy.
9–24 ft BASALT: decomposed; brown CLAY with green waxy fragments, 9–18 ft.
Remarks: Water (9 ft).

BMP 1035 (Grid Ref. 934302; Map Sheet 3)
0–18 ft CLAY: brown, very sandy (fine- to medium-grained).
18–27 ft CLAY: red, very sandy (fine-grained).
27–30 ft CLAY: light grey, plastic.
Remarks: Water (21 ft).

BMP 1036 (Grid Ref. 930284; Map Sheet 3)
0– 3 ft LOAM: grey, sandy.
3–12 ft SANDSTONE: grey and brown, medium-grained, decomposed.
12–18 ft SANDSTONE: grey and red, coarse-grained, decomposed; few pebbles.
18–24 ft SANDSTONE: light grey and brown, medium-grained, less decomposed.
24–30 ft CLAY: medium brown, plastic; few green waxy fragments.
30–36 ft CLAY: brown to greenish; soft yellow inclusion decomposed BASALT, 30–33 ft.

BMP 1038 (Grid Ref. 943263; Map Sheet 3)
0–18 ft SANDSTONE: red, medium- to coarse-grained, hard; decomposed.
18–30 ft CLAY: red, plastic; sandy, 18–24 ft.
30–42 ft CLAY: medium brown, plastic; few clayey nodules with yellow specks.
42–48 ft CLAY: purplish, plastic.

BMP 1039 (Grid Ref. 949253; Map Sheet 3)
0– 6 ft LOAM: grey, sandy.
6–12 ft CLAY: grey and brown, plastic, sandy.
12–18 ft CLAY: medium brown, plastic, sandy (medium-grained).
18–24 ft CLAY: brown, very sandy (medium-grained); few small pebbles.
24–36 ft BASALT: decomposed.

BMP 1040 (Grid Ref. 925257; Map Sheet 3)
0– 6 ft LOAM: sandy.
6–12 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.
12–15 ft SANDSTONE: yellow-brown, medium-grained, decomposed.
15–30 ft SANDSTONE: red, medium-grained.

BMP 1056 (Grid Ref. 553659; Map Sheet 5)
0–15 ft CLAY: brown-green, plastic; numerous shale fragments.
15–24 ft CLAY: medium brown plastic; calcareous nodules up to 1½ inches.
24–30 ft CLAY: light to medium brown, plastic.

BMP 1057 (Grid Ref. 558649; Map Sheet 5)
0– 3 ft CLAY: brown, plastic.
3–18 ft CLAY: light green, plastic, calcareous.
18–24 ft CLAY: light grey and white, calcareous.
Remarks: Water (24 ft).

BMP 1060 (Grid Ref. 566639; Map Sheet 5)
0– 9 ft CLAY: light brown, plastic.
9–24 ft CLAY: yellow-brown to medium brown, plastic.
24–30 ft CLAY: dark green, plastic.

BMP 1061 (Grid Ref. 567648; Map Sheet 5)
0–24 ft CLAY: light green, plastic, calcareous.

BMP 1062 (Grid Ref. 568653; Map Sheet 5)
0– 3 ft CLAY: brown.
3–12 ft CLAY: light green.
12–24 ft SHALE: light green, calcareous.

BMP 1070 (Grid Ref. 580692; Map Sheet 5)
0– 3 ft LOAM: grey, sandy.
3– 9 ft CLAY: light brown, plastic.
9–18 ft CLAY: dark green, plastic, calcareous.
18–24 ft SHALE: dark green.
Remarks: Water (18 ft).

BMP 1079 (Grid Ref. 611651; Map Sheet 5)
0–12 ft CLAY: light to medium brown, plastic.
12–18 ft CLAY: purplish, plastic.
18–24 ft CLAY: purplish-red, plastic.
Remarks: Water (24 ft).

BMP 1080 (Grid Ref. 616649; Map Sheet 5)
0– 3 ft LOAM: grey.
3–12 ft CLAY: brown, very sandy.
12–21 ft SAND: light grey, fine-grained, clayey.
Remarks: Water (21 ft).

BMP 1083 (Grid Ref. 585655; Map Sheet 5)
0– 6 ft CLAY: medium brown, plastic.
6– 9 ft CLAY: brown to light green, plastic.
9–12 ft CLAY: light grey and red, plastic.
12–27 ft CLAY: yellow-brown, plastic.
27–30 ft CLAY: dark green, plastic, calcareous.

BMP 1087 (Grid Ref. 578632; Map Sheet 5)
0– 9 ft SANDSTONE: red, ferruginous, hard; coarse-grained.

APPENDIX—continued

BMP 1088 (Grid Ref. 575638; Map Sheet 5)
0–12 ft CLAY: red, hard.
12–18 ft SANDSTONE: grey to red, fine-grained, decomposed.

BMP 1089 (Grid Ref. 576647; Map Sheet 5)
0– 9 ft CLAY: medium to dark brown, plastic.
9–15 ft CLAY: light yellow-brown, plastic.
15–18 ft CLAY: yellow-brown, plastic.
18–21 ft CLAY: yellow-brown and dark green, plastic.
21–30 ft CLAY: dark green, plastic, calcareous; few gypsum crystals.

BMP 1090 (Grid Ref. 578656; Map Sheet 5)
0–18 ft CLAY: light grey to light brown, plastic.
18–24 ft CLAY: medium brown, plastic.
24–27 ft CLAY: dark brown, plastic.
27–30 ft CLAY: dark green, plastic.

BMP 1091 (Grid Ref. 573656; Map Sheet 5)
0–15 ft CLAY: medium brown, plastic.
15–30 ft CLAY: light green, plastic, calcareous.

BMP 1092 (Grid Ref. 588650; Map Sheet 5)
0– 6 ft CLAY: light grey, plastic.
6–24 ft CLAY: yellow-brown, plastic.
24–27 ft CLAY: dark green, plastic, calcareous.

BMP 1093 (Grid Ref. 585655; Map Sheet 5)
0– 6 ft CLAY: brown, plastic.
6–30 ft CLAY: light green, plastic, calcareous.
Remarks: Water (30 ft).

BMP 1094 (Grid Ref. 574688; Map Sheet 5)
0– 6 ft CLAY: medium brown, plastic.
6– 9 ft CLAY: light green, plastic, calcareous.
9–18 ft SHALE: light green.

BMP 1108 (Grid Ref. 638720; Map Sheet 5)
0– 3 ft LOAM: sandy.
3–12 ft CLAY: red, very sandy.
12–24 ft SANDSTONE: light grey, fine- to medium-grained, decomposed.

Log by: B. R. Houston

BMP 1257 (Grid Ref. 586001; Map Sheet 1)
0– 2 ft SOIL: brown.
2–11 ft SILT: brown, clayey.
11–14 ft SILT: light grey, clayey.
Remarks: Water (9 ft).

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CAINOZOIC

QUATERNARY

Qa — *Alluvial sand silt, mud, clay and gravel*

Qt — **Tennyson Formation** *Semi-consolidated sandy clay, sand and conglomerate*

UNDIFFERENTIATED

Czl — **Lone Pine Gravel** *Semi - consolidated gravel*

Czw — **Witty Gravel** *Semi - consolidated gravel, sandstone and clay*

TERTIARY

Oxley Group

Ts — **Sunnybank Formation** *Sand, clayey sandstone and gravel with clay, mudstone, siltstone and shale*

Tce — Eight Mile Plains Basalt Member

Tc

Tca — Archerfield Basalt Member

Corinda Formation *Mudstone, shale, minor sandstone and limestone*

Td — **Darra Formation** *Mudstone, siltstone, sandstone and gravel*

Tb — **Undifferentiated** *Basalt*

Tpb — *Upper basalt*

Tp

Tpb — *Lower basalt (section only)*

Petrie Formation *Mudstone, siltstone, sandstone, grit with minor oil shale, brown coal and limestone*

MESOZOIC

LOWER JURASSIC

Jlb — **Brighton Beds** *Calcareous- micaceous siltstone, sandstone, carbonaceous shale with minor ferruginous clay oolite*

MIDDLE TO ?UPPER TRIASSIC

Ipswich Coal Measures

Rmv — **Tivoli - Cooneana Formations (undifferentiated)** *Lithic and feldspathic sandstone with carbonaceous shale, coal and minor conglomerate*

Rmc — **College's Conglomerate** *Polymictic conglomerate with sandstone and minor shale*

Rmr — **Mount Crosby Formation** *Shale and tuff with sandstone and minor conglomerate*

Rms — **Sugar's Basalt** *Spilitic volcanics*

Kholo Sub-Group

Rmm — **Moorooka Formation** *Massive siliceous conglomerate and sandstone with minor shale*

Rmt — **Tingalpa Formation** *Carbonaceous shale, lithic sandstone with minor conglomerate and coal*

Rmb — **Brisbane Tuff** *Rhyolitic tuff, conglomerate, breccia and minor sandstone and shale*

?LOWER TRIASSIC

Rli — **Indooroopilly Intrusives** *Rhyolite and quartz porphyry minor intrusives*

Rle — **Enoggera Granite**

Rlk — **Kholo Creek Quartz-Diorite**

Rls — **Samford Granodiorite**

PALAEOZOIC

?PERMIAN

Pr — **Brookfield Volcanics** *Andesite and rhyolite*
Dykes: and. - andesite; f.p. - feldspar porphyry

Pj — **Jolly's Lookout andesites** *Andesite*

?SILURIAN

Sn — **Neranleigh – Fernvale "Group"** *Greywacke, siltstone, shale, chert, jasper and basic volcanics*

?PRECAMBRIAN

pEb — **Bunya Phyllite** *Phyllite with minor phyllonite*

pEr — **Rocksberg Greenstones** *Metamorphosed intermediate-basic volcanics*

Brisbane Metamorphics

Copies of this map may be obtained from the Geological Survey Office, Edward St., Brisbane

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- Fault
- Synclinal axis
- Anticlinal axis

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- Defined deposit (see report)
- Undefined deposit (see report)
- ML — Mineral lease
- +Sb — Isolated mineral occurrence
- Auger hole
- A — Abandoned or worked intermittently
- Trend Line
- Strike and dip of strata
- Strike of vertical strata
- Horizontal strata
- Strike and dip of metamorphic foliation
- Strike of vertical foliation
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- Ag — Silver
- Au — Gold
- Ba — Basalt
- Bs — Building stone (sandstone)
- C — Coal
- Cl — Clay - heavy products (bricks etc.)
- Fossil locality floral
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- Cy — Clay - miscellaneous uses
- Gd — Granite - decomposed
- Gr — Granite
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- Gt — Greenstone
- Gv — Gravel
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- Well for petroleum, abandoned or suspended, with show of gas
- Metalliferous mine, open-cut or prospect
- Colliery adit
- Quarry
- Boundary of City of Brisbane
- Gy — Greywacke
- H — Hornfels
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- Sd — Sand, general
- Sg — Sand, glass
- Tu — Tuff
- Vo — Volcanics, other

Geology: Inner suburbs – G.S.Q. Records
Outer suburbs – P.E. Bock, D.J. Casey, F. Cox, L.G. Cuttler, P.L. Ellis, V.R. Forbes, B R. Houston, J.W. Laycock, I.G. Sanker, C.H. Shipway, N.A.H. Simmonds, R.M. Tucker and K.W. Wolff

Compiled, 1963-65, by: Beverley R. Houston

Drawn by J.A.Wright and N.J.Hunt, Drafting Section, Department of Mines, Brisbane

Reference grid is an arbitrary grid based on True North with intervals of 15″ of Latitude and Longitude
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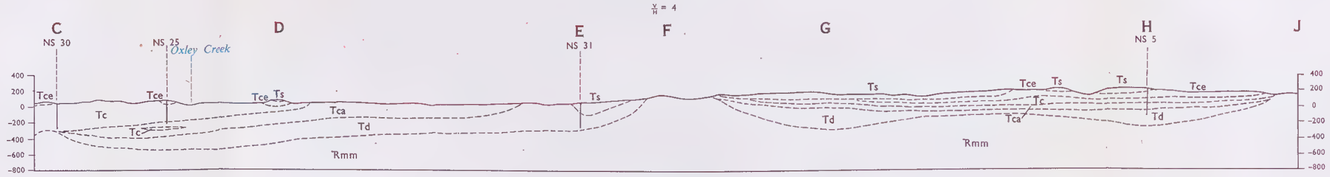
GEOLOGICAL CROSS SECTIONS

Horizontal Scale: One mile to an inch

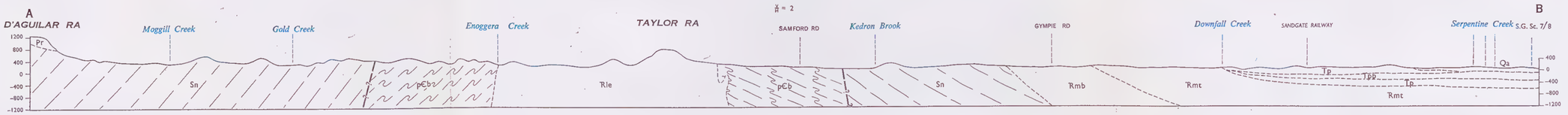
Section C-D-E-F-G-H-J

V/H = 4



Section A-B

V/H = 2

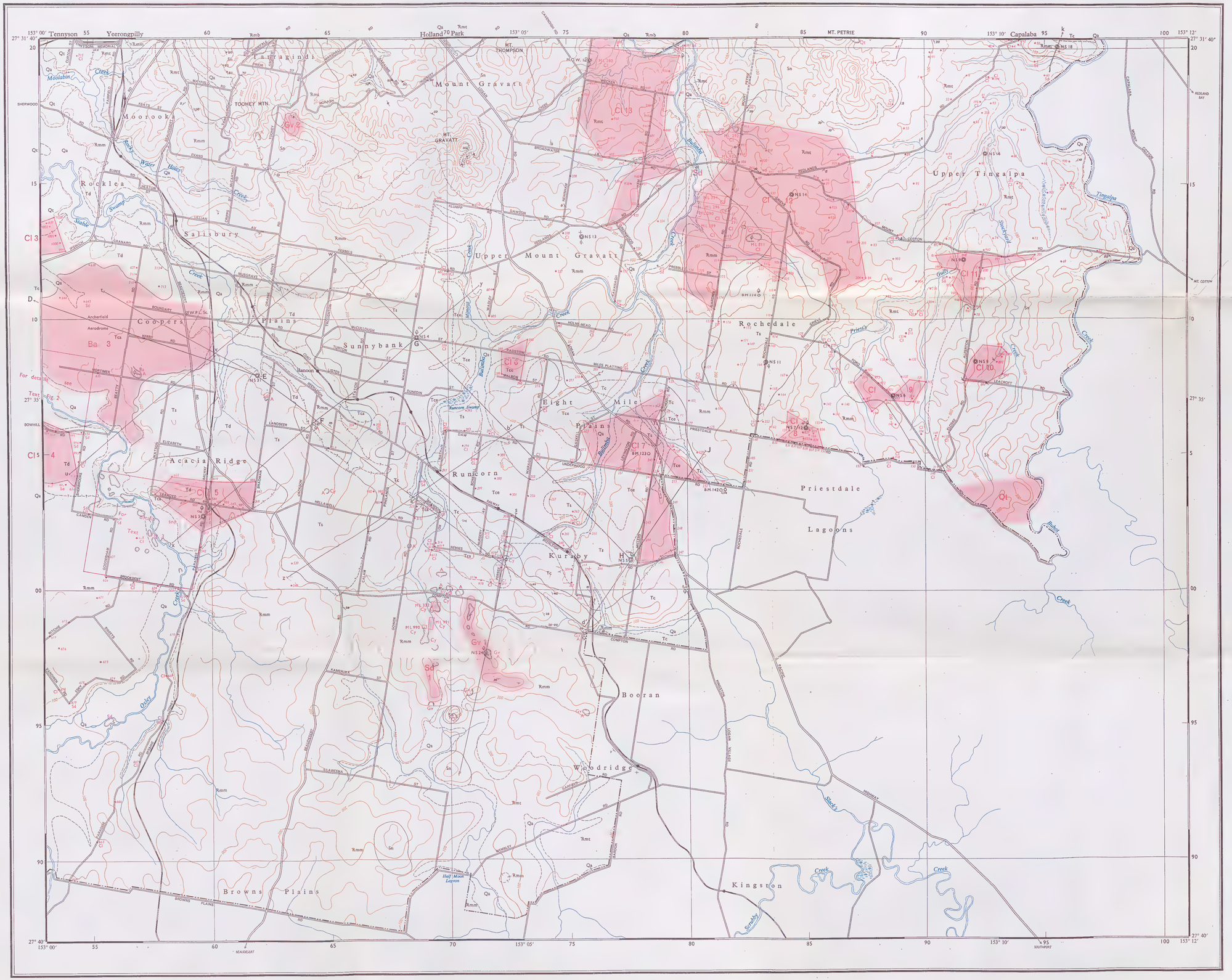


GEOLOGICAL SURVEY OF QUEENSLAND
PUBLICATION NO. 325

CITY OF BRISBANE

ECONOMIC GEOLOGY

FIRST EDITION 1965
SHEET 1



Reference

CAINOZOIC

QUATERNARY

	Qa	Alluvial sand, silt, mud, clay and gravel
Tennyson Formation	Qc	Semi-consolidated sandy clay, sand and conglomerate

TERTIARY

Oxley Group	Sunnybank Formation		Ts — Sand, clayey sandstone and gravel with clay, mudstone, siltstone and shale
	Corinda Formation	Eight Mile Plains Basalt Member	Tce
			Tc — Mudstone, shale; minor sandstone and limestone
		Archerfield Basalt Member	Tca
	Darra Formation		Td — Mudstone, siltstone, sandstone and gravel

MESOZOIC

? MIDDLE TRIASSIC

Moorooka Formation	Rmm	Massive siliceous conglomerate and sandstone with minor shale
Tingalpa Formation	Rmt	Carbonaceous shale, lithic sandstone with minor conglomerate and coal
Brisbane Tuff	Rmb	Rhyolitic tuff, conglomerate, breccia and minor sandstone and shale

PALAEOZOIC

? SILURIAN

Neranleigh – Fernvale "Group"	Sn	Greywacke, siltstone, shale, chert, jasper and basic volcanics

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- Percussion drillhole
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- Vehicle track
- Mangroves
- Swamp
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- Gd Granite-decomposed
- Gs Gem mineral
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- Auger hole
- Well for petroleum, abandoned or suspended, with show of gas
- Colliery adit
- A Abandoned or worked intermittently
- Street or Road
- Railway line with station
- Boundary of City of Brisbane
- Undefined deposit (see report)
- Mn Isolated mineral occurrence
- Gy Greywacke
- H Hornfels
- Mn Manganese
- Na Saline water
- Pb Lead
- Qt Quartzite
- Sb Antimony
- Sd Sand, general
- Sg Sand, glass
- Tu Tuff
- Vo Volcanics, other

SCALE
40 Chains to 1 Inch

40 0 40 80 120 160

1 : 31,680

To accompany report by Beverley R. Houston, B. Sc.(Hons), Geologist

Drawn by N.J.Hunt, Drafting Section, Department of Mines, Brisbane

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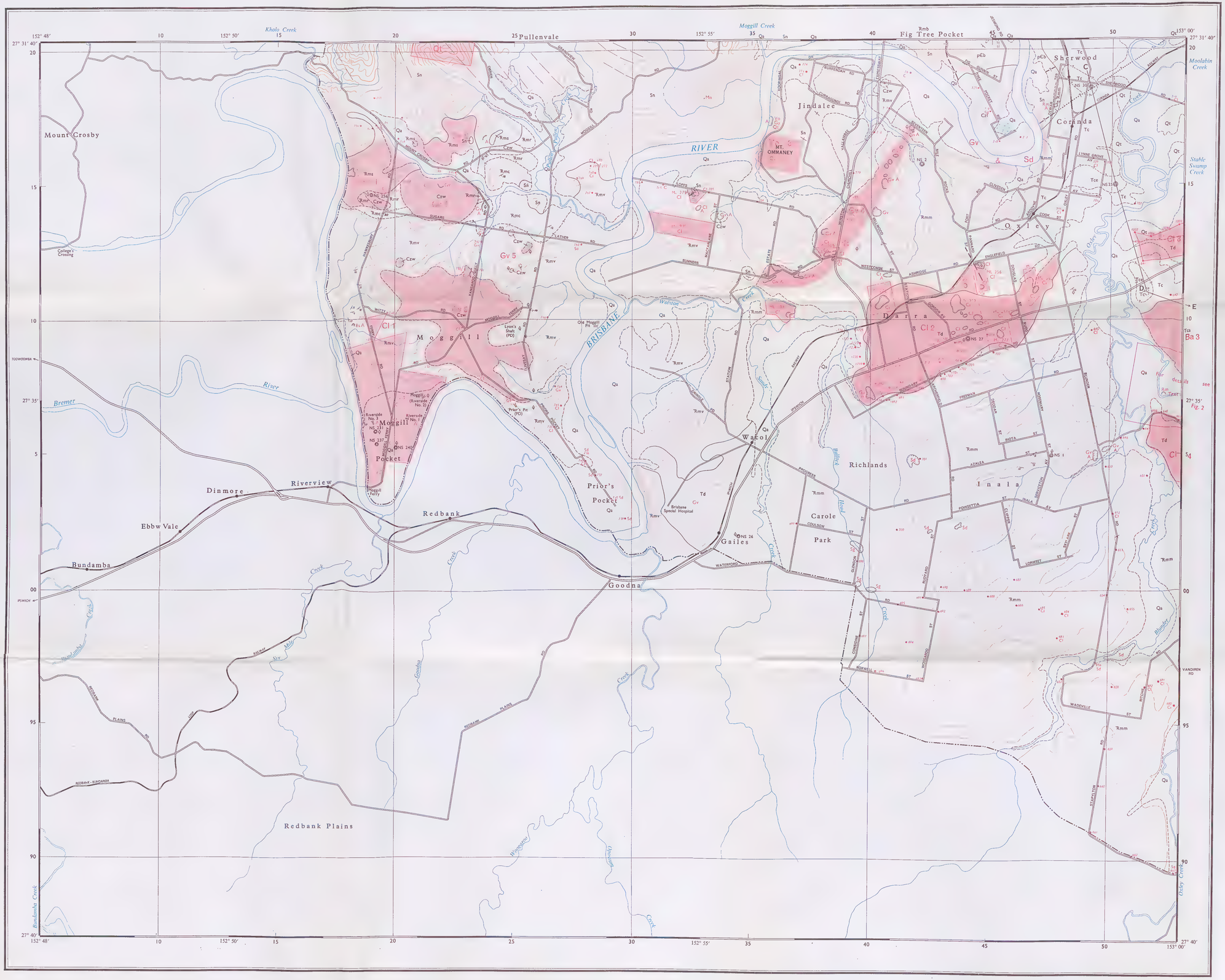

Reference

CAINOZOIC

QUATERNARY

	Qa	Alluvial sand, silt, mud, clay and gravel
Tennyson Formation	Qc	Semi-consolidated sandy clay, sand and conglomerate

UNDIFFERENTIATED

Lone Pine Gravel	Czl	Semi - consolidated gravel
Witty Gravel	Czw	Semi - consolidated gravel, sandstone and clay

TERTIARY

Oxley Group	Sunnybank Formation	Ts	Sand, clayey sandstone and gravel with clay, mudstone, siltstone and shale
	Corinda Formation — Eight Mile Plains Basalt Member	Tce	Basalt
	Corinda Formation	Tc	Mudstone, shale, minor sandstone and limestone
	Corinda Formation — Archerfield Basalt Member	Tca	Basalt
	Darra Formation	Td	Mudstone, siltstone, sandstone and gravel

MESOZOIC

?MIDDLE TRIASSIC

Moorooka Formation	Rmm	Massive siliceous conglomerate and sandstone with minor shale
Brisbane Tuff	Rmb	Rhyolitic tuff, conglomerate, breccia and minor sandstone and shale
Ipswich Coal Measures — Tivoli - Cooneana Formations (undifferentiated)	Rmv	Lithic and feldspathic sandstone with carbonaceous shale, coal and minor conglomerate
Ipswich Coal Measures — Khola Sub-group — College's Conglomerate	Rmc	Polymictic conglomerate with sandstone and minor shale
Ipswich Coal Measures — Khola Sub-group — Mount Crosby Formation	Rmr	Shale and tuff with sandstone and minor conglomerate
Ipswich Coal Measures — Khola Sub-group — Sugar's Basalt	Rms	Spilitic volcanics

PALAEOZOIC

? SILURIAN

Neranleigh – Fernvale "Group"	Sn	Greywacke, siltstone, shale, chert, jasper and basic volcanics

? PRECAMBRIAN

Bunya Phyllite	pCb	Phyllite with minor phyllonite

Geological boundary
Fault
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Synclinal axis
Trend Line

Strike and dip of strata
Horizontal strata
Strike of vertical foliation
Fossil locality, floral
Section line
Diamond drillhole
Drillhole type other
Metalliferous mine, open-cut or prospect
Quarry
Main access road
Vehicle track
Swamp
Defined deposit (see report)
Mineral lease

Strike of vertical strata
Strike and dip of metamorphic foliation
Strike and dip of cleavage
Fossil locality, faunal
Text section line
Percussion drillhole
Auger hole
Colliery adit
Abandoned or worked intermittently
Street or Road
Railway line with station
Boundary of City of Brisbane
Undefined deposit (see report)

Ag	Silver	Gy	Greywacke
Au	Gold	Mn	Manganese
Ba	Basalt	Qz	Quartzite
C	Coal	Rm	Road material - type unspecified
Cl	Clay-heavy products (bricks ect.)	Sd	Sand, general
Cy	Clay-miscellaneous uses	Sg	Sand, glass
Gv	Gravel	Vo	Volcanics, other

Isolated mineral occurrence: •Mn

SCALE
40 Chains to 1 Inch

40 0 40 80 120 160

1: 31,680

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ECONOMIC GEOLOGY

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Reference

CAINOZOIC
QUATERNARY

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Tennyson Formation	Qt	Semi-consolidated sandy clay, sand and conglomerate

TERTIARY

Petrie Formation	Tp	Mudstone, siltstone, sandstone, grit with minor oil shale, brown coal and limestone
Oxley Group — Sunnybank Formation	Ts	Sand, clayey sandstone and gravel with clay, mudstone, siltstone and shale
Oxley Group — Corinda Formation — Eight Mile Plains Basalt Member	Tce	Basalt
Oxley Group — Corinda Formation	Tc	Mudstone, shale, minor sandstone and limestone
Oxley Group — Corinda Formation — Archerfield Basalt Member	Tca	Basalt
Undifferentiated	Tb	Basalt

MESOZOIC
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PALAEOZOIC
? SILURIAN

Neranleigh – Fernvale "Group"	Sn	Greywacke, siltstone, shale, chert, jasper and basic volcanics

? PRECAMBRIAN

Bunya Phyllite	pCb	Phyllite with minor phyllonite

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- Fossil locality, faunal
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- a–b Text section line
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- Well for petroleum, abandoned or suspended, with show of gas
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- Colliery adit
- Quarry
- Abandoned or worked intermittently
- Main access road
- Street or Road
- Vehicle track
- Railway line with station
- Swamp
- Salt pan and mud flat
- Mangroves
- Boundary of City of Brisbane

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- Sd Sand, general
- Gs Gem mineral
- Sg Sand, glass
- Gt Greenstone
- Tu Tuff
- Gv Gravel
- Vo Volcanics, other

SCALE
40 Chains to 1 Inch

40 0 40 80 120 160

1 : 31,680

To accompany report by Beverley R. Housson, B. Sc.(Hons), Geologist

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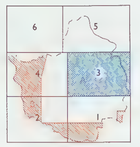

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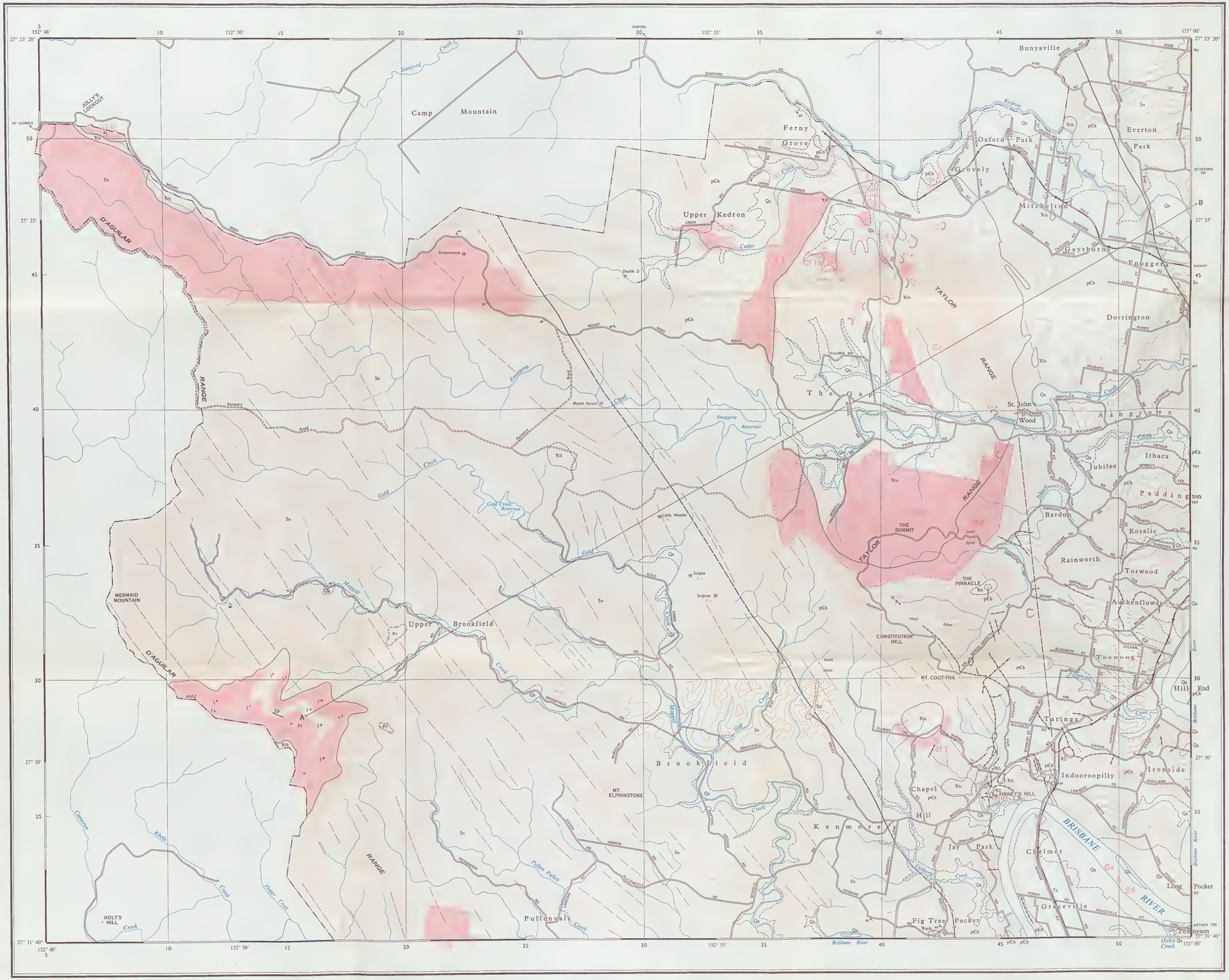

Reference

CAINOZOIC

QUATERNARY

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- Tennyson Formation — Qt — Semi-consolidated sandy clay, sand and conglomerate

TERTIARY

- Corinda Formation — Tc — Mudstone, shale, minor sandstone and limestone

MESOZOIC

? MIDDLE TRIASSIC

- Brisbane Tuff — Rmb — Rhyolitic tuff, conglomerate, breccia and minor sandstone and shale

LOWER TRIASSIC

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PALAEOZOIC

? PERMIAN

- Brookfield Volcanics — Pr — Andesite and rhyolite. Dykes: and. - andesite, f.p. - feldspar porphyry
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Fossil locality, faunal
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Text section line
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Percussion drillhole
Drillhole type other
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Metalliferous mine, open-cut or prospect
Colliery adit
Quarry
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Main access road
Street or Road
Vehicle track
Railway line with station
Boundary of City of Brisbane
Defined deposit (see report)
Undefined deposit (see report)
Mineral lease
Isolated mineral occurrence

Ag	Silver	Gy	Greywacke
Au	Gold	H	Hornfels
Bs	Basalt	Mn	Manganese
Bs	Building stone (sandstone)	Na	Saline water
C	Coal	Pb	Lead
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SCALE
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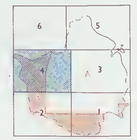

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CITY OF BRISBANE

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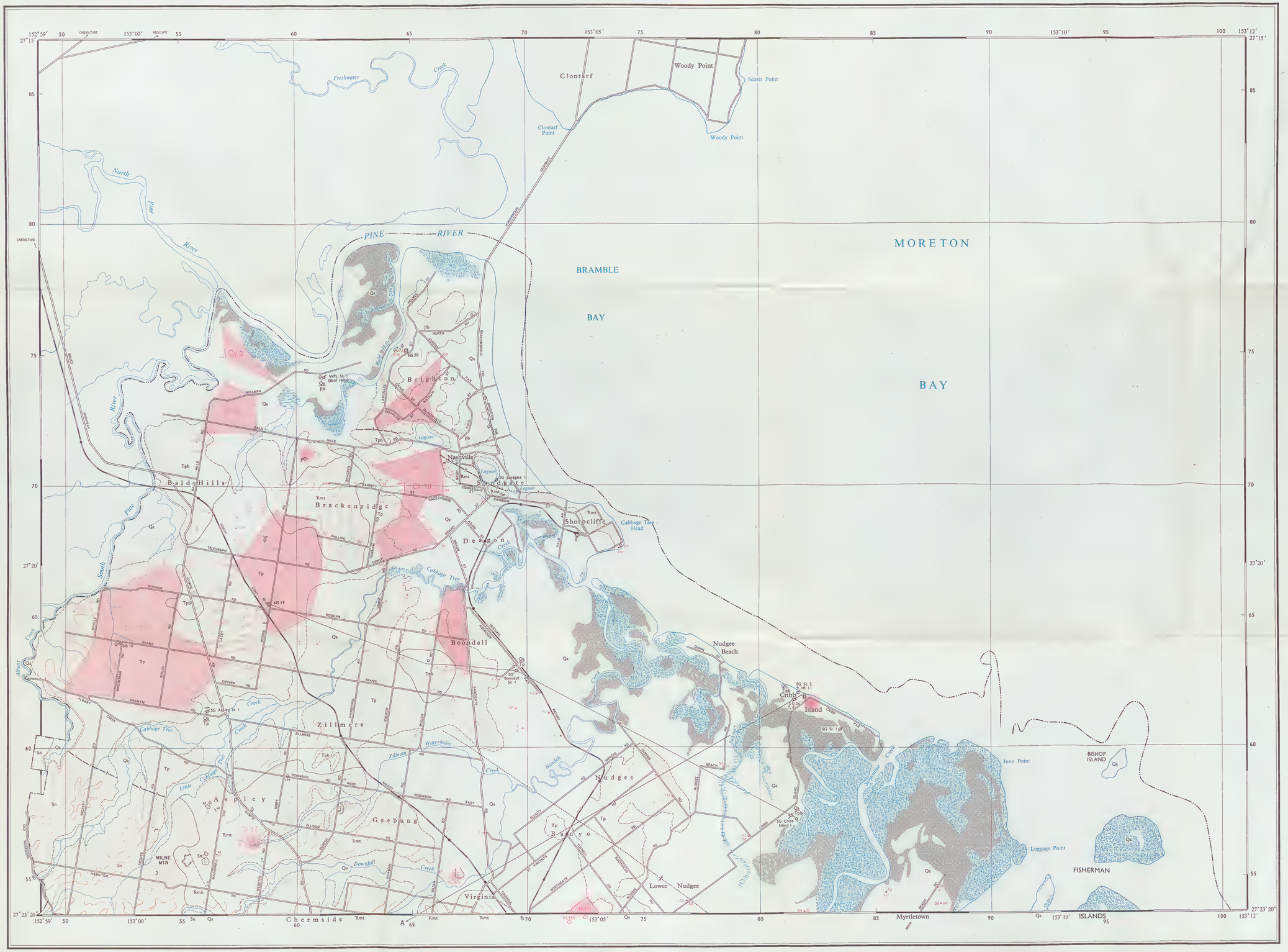

Reference

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TERTIARY

Petrie Formation

Tpb — Upper basalt
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LOWER JURASSIC

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PALAEOZOIC

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- Proven economic deposit (see report)
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- Potential deposit (see report)
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Gt	Greenstone	Tu	Tuff
Gv	Gravel	Va	Volcanics, other

SCALE
40 Chains to 1 Inch

40 0 40 80 120 160

1 : 31,680

To accompany report by Beverley R. Houston, B. Sc.(Hons), Geologist

Drawn by J.A.Wright, Drafting Section, Department of Mines, Brisbane

Reference grid is an arbitrary grid based on True North with intervals of 15″ of Latitude and Longitude
References are given with Existing first, thus Point, Diamond Drillhole NG 10 East 52·3, North 64·0 Reference : 523640

INDEX TO SHEETS

A: Contours from a map supplied by the Topographic Branch, Survey Office, Department of Public Lands, Brisbane
B: Contours from R.A.S.C. 1 : 63,360 Series

CITY OF BRISBANE

ECONOMIC GEOLOGY

SHEET 5

Copies of this map may be obtained from the Geological Survey Office, Edward St., Brisbane

632.09g
Q 31

QUEENSLAND
DEPARTMENT OF MINES

NATIONAL MUSEUM
29 OCT 1965
OF VICTORIA

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 326

TERTIARY BASALTS OF THE CITY OF BRISBANE AND ENVIRONS, SOUTH-EAST QUEENSLAND

by BEVERLEY R. HOUSTON, B.Sc. (Hons.), Geologist

BRISBANE
By Authority: S. G. REID, Government Printer
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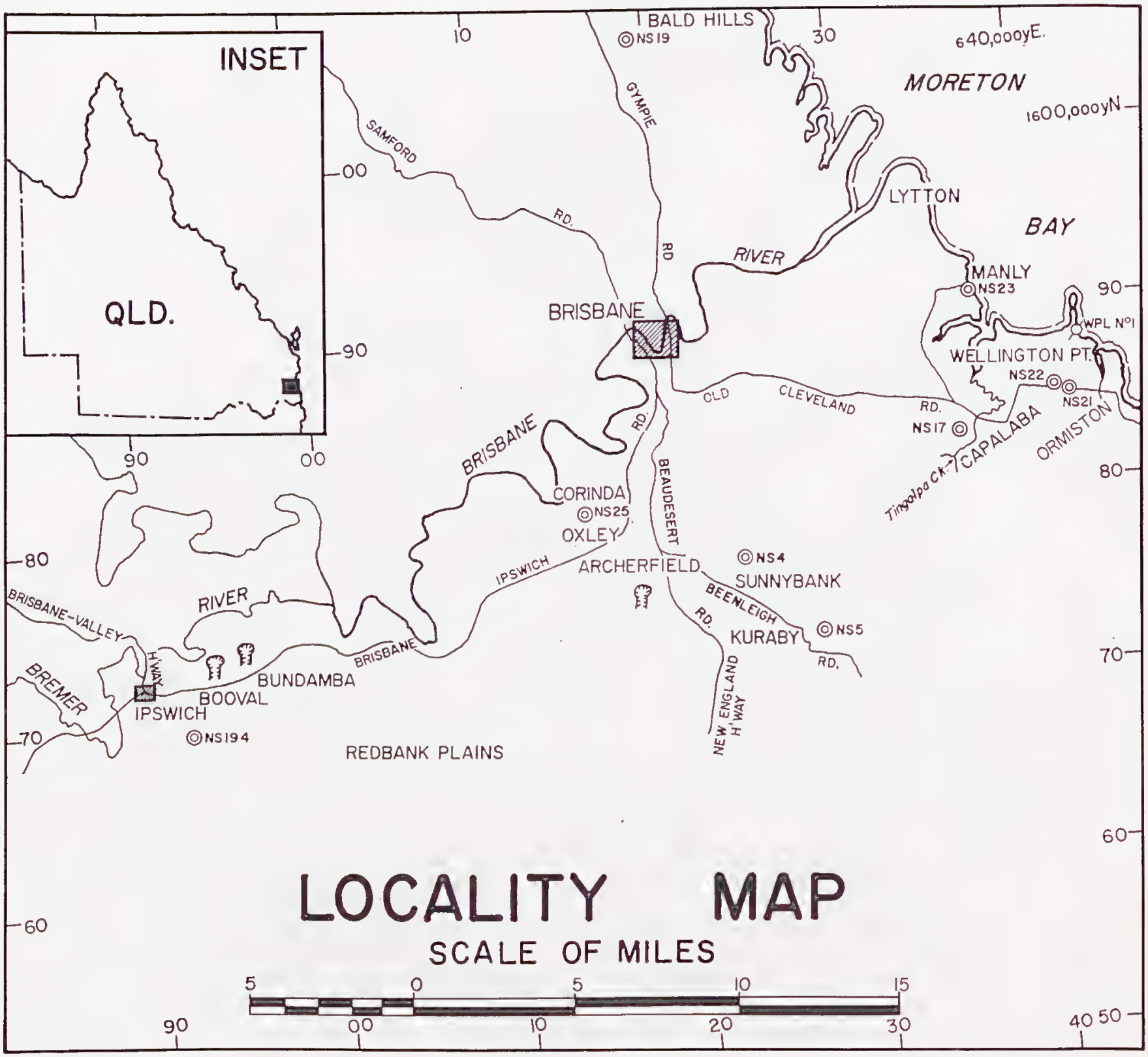
FIGURE 1


INSET
QLD.
10
30
640,000yE.
1600,000yN
BALD HILLS
NS19
MORETON
BAY
LYTTON
GYMPIE
RD
SAMFORD
RD.
RIVER
BRISBANE
MANLY
NS23
WPL No1
WELLINGTON PT.
NS22
NS21
ORMISTON
CAPALABA
OLD CLEVELAND RD.
NS17
Tingalpa Ck
BRISBANE
RD.
CORINDA
NS25
OXLEY
BEAUDESERT
IPSWICH
ARCHERFIELD
NS4
SUNNYBANK
BEENLEIGH
RD.
KURABY
NS5
RD.
NEW ENGLAND H'WAY
BRISBANE-VALLEY
H'WAY
BREMER
BUNDAMBA
BOOVAL
IPSWICH
NS194
REDBANK PLAINS
90
00
80
70
60
40 50
LOCALITY MAP
SCALE OF MILES
5 0 5 10 15
90 00 10 20 30

TERTIARY BASALTS OF THE CITY OF BRISBANE AND ENVIRONS, SOUTH-EAST QUEENSLAND

By

BEVERLEY R. HOUSTON, B.Sc. (Hons.), Geologist

ABSTRACT

The mineralogical and chemical properties of some Tertiary and presumed Tertiary basalts from the City of Brisbane and its environs are described. It is concluded that the described rocks are probably related in origin and age.

INTRODUCTION

HISTORICAL

The generally decomposed nature of the outcropping Tertiary and presumed Tertiary basalts of the City of Brisbane and its environs has made detailed study of their properties impossible. Richards (1916, p. 175) described one specimen from an unspecified quarry at Bundamba and tabulated (p. 177) chemical analyses of the above specimen and another from Coopers Plains (now Archerfield). There is no further record of mineralogical or chemical studies having been made on the Tertiary basalts of the region except for a description by Denmead (1927) of a specimen from an unspecified locality at Eight Mile Plains.

RECENT WORK

Recent drilling by the Mines Department has made available a representative collection of fresh specimens from the Tertiary and presumed Tertiary basalts of the City of Brisbane and its environs. During the preparation of a report on the geology of the City of Brisbane (Houston, in press) special attention was paid to the above collection. It was hoped that the mineralogical and chemical properties of the basalts would be of use for correlation purposes. The specimens were examined microscopically and chemical analyses were carried out at the Government Chemical Laboratory, Brisbane. Radioactive age determinations by the Potassium–Argon method were not possible owing to an abundance of devitrified glass in the rocks.

ACKNOWLEDGMENTS

My thanks are due to Messrs. R. M. Tucker and H. R. E. Staines of the Geological Survey of Queensland and Mr. H. C. Couper of the Government Chemical Laboratory, Brisbane, for their assistance in the various aspects of this problem.

DISTRIBUTION AND STRATIGRAPHY

Discontinuous basalts of known and presumed Tertiary age occur in the following areas in and about the City of Brisbane (Fig. 1):—

(1) Basalt occurs interbedded with sediments in the Tertiary **Silkstone Formation** of Staines (1960) in the Bundamba-Booval area, Ipswich and Redbank Plains area.

(2) The **Archerfield** and **Eight Mile Plains Basalt Members** occur at the base and at the top (respectively) of the Tertiary Corinda Formation of Houston (1965). This unit occurs in the Corinda–Archerfield – Sunnybank – Kuraby – Eight Mile Plains area of the southern part of the City of Brisbane and at Capalaba on the City's eastern boundary.

(3) Two distinct basalts occur in the Tertiary **Petrie Formation** (Houston, 1965) about Bald Hills, in the northern part of the City of Brisbane.

(4) A very thick **basalt** section, believed to be of Tertiary age, is known in a downfaulted block (Houston, 1965a) in the Lytton–Manly–Wellington Point–Ormiston area in, and to the east of, the City of Brisbane. No sediments have been found interbedded with these volcanics; from W.P.L. No. 1 (Wellington Point) minor green and red shale was reported to be intercalated with the basalt (Geological Survey of Queensland, 1960). Upon careful examination, this material was found to be decomposed basalt.

PETROLOGY AND CHEMICAL ANALYSES

Petrographic descriptions of the specimens collected appear in Appendix I.

Except for one specimen (microslide GSQ 1232, Fort Lytton) the basalts are hyalo-ophitic to intergranular, fine to medium-grained, commonly porphyritic (Plate I, 3-8). The Lytton specimen is porphyritic with a crudely pilotaxitic groundmass (Plate I, 1 and 2).

These rocks are commonly altered and are characterised by the presence of glass (in general devitrified), titanaugite and labradorite; olivine is of random occurrence. Thus, of two specimens from only a few hundred yards apart in an area of negligible relief (microslides GSQ 3666 and GSQ 2309), only one contains olivine. The estimated modal percentages of feldspar, olivine, glass and pyroxene are shown graphically in Fig. 2. It can be seen that the variation in composition is a random one, unrelated to locality or stratigraphic position.

Thus, the specimens examined are remarkably similar in texture and essential mineralogy except for one specimen, microslide GSQ 1232, a columnar basalt from Fort Lytton. This rock may represent an eruption centre (Houston, in press).

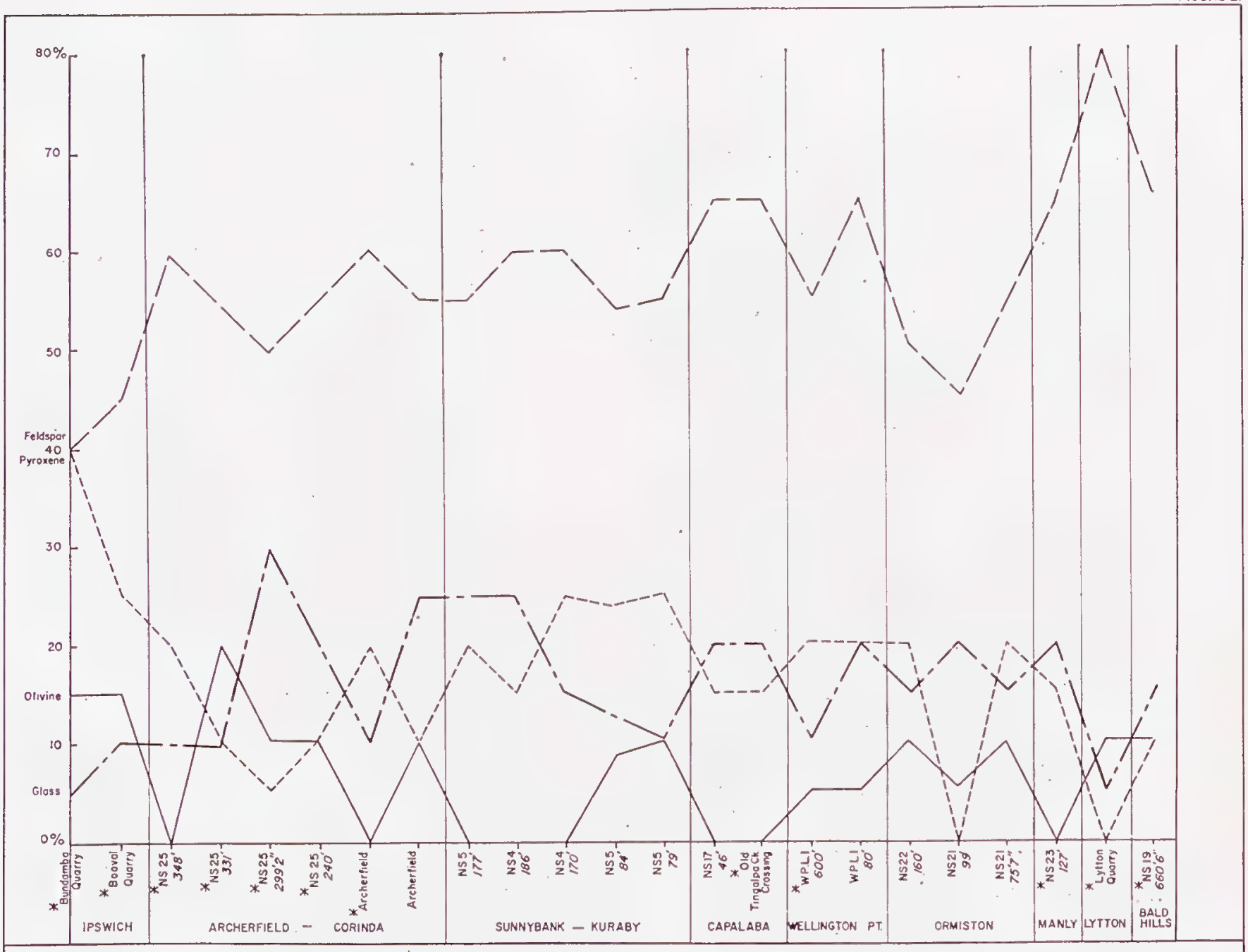
All available results of relevant chemical analyses are given in Table I together with the Tholeiitic and Olivine Basalt Magma Types of Kennedy (1933).

Attempts to depict graphically the variation in chemical composition showed clearly that, as with the mineralogical composition, the chemical variation is random. The range in chemical composition in one unit at a certain locality is as great as that between samples from as far apart as Bundamba and Ormiston. No trends of magmatic evolution or differentiation were evident in the material examined.

CORRELATION AND AGE

Indisputable evidence for correlation of these basalts could not be found. They are, however, similar in their essential characteristics and occur, distributed at random, in a relatively small region. It is thus concluded that the Tertiary and presumed Tertiary basalts of the City of Brisbane and its environs are probably related in origin and age.

FIGURE 2.



MODAL PERCENTAGES OF FELDSPAR, PYROXENE, OLIVINE & GLASS

*(Chemical analysis given in Table I.)

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TABLE 1

CHEMICAL ANALYSES

Unit	Silkstone Formation				Archerfield Basalt Member								
Locality	Bundamba	Bundamba	Booval	N.S. 194	N.S. 25				Archer-field	Archer-field	N.S. 4	N.S. 5	N.S. 17
Reference	Unspeci-fied	954735*	940733*	920712*	148805*				176768†	179765†	231773†	270731†	357831†
Sample Site	Quarry	Quarry	Quarry	802′	238′ 10″	299′ 3″	331′ 2″	347′ 11½″	Quarry	Surface	158′–180′	"Lower Basalt"	139′–140′
Rock Name Microslide No.	Basalt	Olivine Basalt GSQ 3681	Olivine Basalt GSQ 3682	—	Olivine Basalt GSQ 3667	Olivine Basalt GSQ 3668	Olivine Basalt GSQ 3669	Basalt GSQ 3670	Basalt	Basalt GSQ 3666	—	—	—
SiO_2%	51·69	51·3	51·7	51·0	50·0	50·0	49·6	50·0	50·24	48·4	46·6	45·6	43·0
Al_2O_3%	13·16	14·8	15·3	15·4	15·8	15·7	16·2	15·5	16·59	14·1	13·7	12·1	12·0
MgO%	6·84	6·1	6·1	5·8	5·5	5·5	5·0	5·9	5·14	6·45	7·1	9·64	5·6
CaO%	8·41	7·7	7·7	7·2	7·2	7·0	6·9	6·6	7·52	9·15	6·8	7·85	8·5
Na_2O%	2·76	3·72	3·50	3·44	3·40	3·51	3·62	3·20	3·54	3·10	3·0	2·44	3·0
K_2O%	0·45	0·66	0·36	0·68	0·44	0·28	0·44	0·48	0·40	0·26	0·13	0·39	0·19
FeO%	8·65	7·9	8·3	7·0	4·5	2·7	3·4	3·5	8·35	8·7	4·2	7·4	5·4
Fe_2O_3%	3·99	2·64	2·74	2·33	6·0	7·2	6·0	6·1	2·72	2·80	5·8	4·7	5·1
H_2O^+%	1·00	1·65	1·37	2·53	0·8	1·06	1·40	1·25	1·14	1·78	3·65	3·41	4·3
H_2O^-%	0·55	1·65	1·23	2·37	4·3	5·3	5·1	5·10	1·02	0·60	5·15	2·40	4·4
CO_2%	ND	0·62	0·31	0·58	0·27	0·27	0·40	0·45	ND	3·35	1·4	0·70	6·4
TiO_2%	1·70	1·59	1·41	1·67	1·33	1·56	1·53	1·70	0·72	1·75	1·77	2·20	1·65
P_2O_5%	0·28	0·18	0·14	0·21	0·18	0·22	0·26	0·25	0·41	0·32	0·37	0·45	0·43
MnO%	0·14	0·14	0·16	0·16	0·11	0·12	0·11	0·10	0·29	0·20	0·05	0·20	0·26
BaO%	ND	ND	ND	ND	ND	ND	ND	ND	ND	trace	ND	trace	ND
Cr_2O_3%	ND	ND	ND	ND	ND	ND	ND	ND	ND	nil	ND	nil	ND
Total % ..	99·62	100·65	100·32	100·37	99·83	100·42	99·96	101·13	99·96	100·96	99·72	99·48	100·23
	1	2	3	4	5	6	7	8	9	10	11	12	13

TABLE 1—continued

Unit	Eight Mile Plains Basalt Member				Tertiary basalt undifferentiated						Petrie Formation	Tholeiitic Magma Type	Olivine Basalt Magma Type
Locality	N.S. 5	N.S. 17	Old Crossing, Tingalpa Creek		W.P.L. 1 Wellington Point		N.S. 22	N.S. 21	N.S. 23	Lytton	N.S. 19	Average Kennedy (1933)	Average Kennedy (1933)
Reference	270731†	357831†	365835†		422877‡		410848†	414847†	366907‡	339963‡	192057‡		
Sample Site	Upper Basalt	70′–80′	Creek Bed		600′–610′	340′–350′	189′ 6″	92′ 0″	128′	Quarry	660′ 6″		
Rock Name Microslide No.	—	—	Basalt GSQ 2313	Basalt	Olivine Basalt GSQ 3679	—	—	—	Basalt GSQ 3674	Olivine Basalt GSQ 1232	Olivine Basalt GSQ 3672	—	—
SiO_2%	48·7	46·0	48·0	48·74	46·6	46·2	44·5	47·8	51·0	44·2	47·7	50	45
Al_2O_3%	12·5	15·6	14·0	16·49	16·0	16·2	14·6	17·0	15·3	14·0	17·6	13	15
MgO%	6·75	6·2	8·50	6·16	7·0	6·25	4·7	3·4	4·8	10·1	5·1	5	8
CaO%	9·60	9·3	7·40	8·28	8·0	7·6	9·8	6·6	7·6	7·95	8·9	10	9
Na_2O%	3·02	3·1	2·70	2·88	2·57	2·18	1·80	2·38	3·75	2·68	2·50	2·8	2·5
K_2O%	0·40	0·38	0·26	0·79	1·78	1·96	1·78	1·20	0·52	1·60	0·80	1·2	0·5
FeO%	8·1	4·6	7·80	7·43	4·0	3·2	4·16	6·0	4·88	9·0	5·6	} 13	13
Fe_2O_3%	1·85	5·7	3·58	2·63	6·5	7·2	7·8	2·9	4·54	3·10	2·3		
H_2O^+%	1·19	3·1	2·85	1·62	3·8	4·7	3·24	4·25	1·72	2·56	2·5	..	..
H_2O^-%	0·50	2·54	2·90	3·73	2·0	2·4	3·56	5·0	4·15	0·94	3·0	..	..
CO_2%	3·55	1·55	0·67	ND	0·22	0·2	1·82	1·97	0·46	0·65	1·86	..	..
TiO_2%	2·06	1·6	1·70	1·46	1·49	1·53	2·07	1·34	1·52	2·85	1·55	..	..
P_2O_5%	0·42	0·43	0·27	0·24	0·42	0·39	0·62	0·40	0·14	0·76	0·23	..	..
MnO%	0·20	0·17	0·20	0·14	0·16	0·08	0·18	0·08	0·16	0·20	0·16	..	..
BaO%	trace	ND	trace	ND	0·04	0·02	ND	0·04	ND	trace	ND	..	..
Cr_2O_3%	nil	ND	nil	ND	ND	ND	ND	ND	ND	nil	ND	..	..
Total% ..	98·84	100·27	100·83	100·59	100·58	100·11	100·63	100·36	100·54	100·59	99·80	..	..
	14	15	16	17	18	19	20	21	22	23	24	25	26

* Reference to Military Map No. 192 Ipswich, One Mile Series. Second Edition.
† Reference to Military Map No. 193 Beenleigh, One Mile Series. Second Edition.
‡ Reference to Military Map No. 183 Brisbane, One Mile Series.
Analyses 1 and 9—G. R. Patten, Agricultural Chemical Laboratory, Brisbane, 1914 and 1912 respectively.
Analyses 2–8, 10–16, 18–24—C. H. Couper, Government Chemical Laboratory, Brisbane, 1964.
Analysis 17—Avery and Anderson, Melbourne, 1961.

APPENDIX I

DETAILED PETROLOGY

SILKSTONE FORMATION

MICROSLIDE: * **GSQ 3681 (ex GSQ/R 2692).**

LOCALITY: **Abandoned City Council quarry near Bundamba rail station.**
1-m. Mil. Map: Ipswich (953735).

MACRO: A massive, uneven-grained, ophitic, dark grey rock.

MICRO:

TEXTURE: Ophitic to hyalo-ophitic, 0·25 to 5 mm.

CONSTITUENTS:

Labradorite: about 40% of rock; fresh.
Olivine: about 15% of rock; essentially *serpentinised.*
?Titanaugite: about 40% of rock; fresh, coarse.
Devitrified glass: about 5% of rock; brown.
Opaques: minor.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: * **GSQ 3682 (ex GSQ/R 2693).**

LOCALITY: **Ipswich City Council quarry, Dudley Street, Booval.**
1-m. Mil. Map: Ipswich (940733).

MACRO: A massive, uneven-grained, ophitic, dark grey rock.

MICRO:

TEXTURE: Sub-ophitic to ophitic and hyalo-ophitic, 0·2 to 2 mm.

CONSTITUENTS:

Labradorite: about 45% of rock; fresh.
Olivine: about 15% of rock; essentially altered.
Clinopyroxene: about 25% of rock; fresh.
Devitrified glass: about 10% of rock; brown.
Opaques: about 5% of rock, anhedral.

VEINS: Minor *calcite* veins traverse the rock.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

ARCHERFIELD BASALT MEMBER

MICROSLIDE: * **GSQ 3670.**

LOCALITY: **Brisbane N.S. 25 (Corinda),** 347 ft. 11½ in.
1-m. Mil. Map: Ipswich (148805).

MACRO: A massive, fine-grained, greenish-grey rock.

MICRO: Essentially similar to GSQ 3666 except in the following:—

(1) The glass in GSQ 3670 is devitrified (green).

(2) The grain size of GSQ 3670 is 0·5 to 1 mm.

NAME: BASALT.

MICROSLIDE: * **GSQ 3669.**

LOCALITY: **Brisbane N.S. 25 (Corinda),** 331 ft.
1-m. Mil. Map: Ipswich (148805).

MACRO: A massive, fine-grained, greenish-grey, porphyritic rock.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 10%) are about 1·5 mm., acicular. The groundmass is intersertal, about 0·2 to 0·5 mm.

PHENOCRYSTS:

Labradorite: about 10% of rock.

GROUNDMASS:

Labradorite: about 45% of rock; fresh.
Olivine: about 20% of rock; *serpentinised* and *iddingsitised.*
Titanaugite: about 10% of rock.
Devitrified glass: about 10% of rock; brown.
Opaques: about 5% of rock; fine rods.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: * **GSQ 3668.**

LOCALITY: **Brisbane N.S. 25 (Corinda),** 299 ft. 2 in.
1-m. Mil. Map: Ipswich (148805).

MACRO: A massive, fine-grained, greenish-grey rock.

MICRO:

TEXTURE: Hyalo-ophitic, 0·25 to 0·5 mm.

CONSTITUENTS:

Labradorite: about 50% of rock; fresh.
Olivine: about 10% of rock; *iddingsitised.*
Titanaugite: about 5% of rock.
Devitrified glass: about 30% of rock; brown.
Opaques: about 5% of rock; fine rods.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: * **GSQ 3667.**

LOCALITY: **Brisbane N.S. 25 (Corinda),** 240 ft.
1-m. Mil. Map: Ipswich (148805).

MACRO: A massive, fine-grained, dark grey rock.

MICRO:

TEXTURE: Intersertal to intergranular, 0·08 to 0·75 mm.

CONSTITUENTS:

Labradorite: about 55% of rock; fresh.
Olivine: about 10% of rock; iddingsitised.
Titanaugite: about 10% of rock.
Devitrified glass: about 20% of rock; green and brown.
Opaques: about 5% of rock; minute rods.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

---

* Chemical analysis given in Table 1.

MICROSLIDE: * **GSQ 3666 (ex $\frac{GSQ/R}{2689}$).**

LOCALITY: **South of Mortimer Road, Archerfield.**
1-m. Mil. Map: Ipswich (179765).

MACRO: A massive, fine-grained, dark grey rock.

MICRO:

TEXTURE: Sub-ophitic and hyalo-ophitic to intersertal, about 0·2 mm.

CONSTITUENTS:

Labradorite (c.An$_{55}$)*:* about 60% of rock; fresh.

Titanaugite: about 20% of rock; fairly fresh.

Glass: about 10% of rock; yellow-brown, very slightly devitrified in part.

Calcite: about 5% of rock; secondary, filling interstices.

Opaques: about 5% of rock; fine rod-like bodies disposed at random.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

MICROSLIDE: **GSQ 2309.**

LOCALITY: **Archerfield (quarry).**
1-m. Mil. Map: Beenleigh (176768).

MACRO: No specimen available.

MICRO:

TEXTURE: Intergranular to hyalo-ophitic, 0·08 to 0·5 mm.

CONSTITUENTS:

Labradorite: about 55% of rock.

Olivine: about 10% of rock; fresh to *serpentinised,* granular.

Titanaugite: about 10% of rock; *serpentinised* in part.

Glass: about 25% of rock; green to brown.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDES: **GSQ 3001, 3002.**

LOCALITY: **Brisbane N.S. 4 (Sunnybank),** 186 ft. 5 in.–186 ft. 10 in.
1-m. Mil. Map: Beenleigh (231773).

MACRO: A massive, very fine-grained, dark grey rock traversed by fine carbonate veins.

MICRO:

TEXTURE: Hyalo-ophitic to intersertal, about 0·2 mm.

CONSTITUENTS:

Labradorite: about 60% of rock; fairly fresh.

Serpentine: about 15% of rock; associated with minor relic *clinopyroxene.*

Devitrified glass: about 25% of rock; deep red-brown.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

MICROSLIDE: **GSQ 3000.**

LOCALITY: **Brisbane N.S. 4 (Sunnybank),** 170 ft. 5 in.–170ft. 8 in.
1-m. Mil. Map: Beenleigh (231773).

MACRO: A massive, fine-grained, medium and dark grey mottled rock traversed by fine carbonate veins.

MICRO:

TEXTURE: Sub-ophitic to hyalo-ophitic, about 0·2 mm.

CONSTITUENTS:

Labradorite (c. An$_{64}$)*:* about 60% of rock.

Serpentine: about 5% of rock; filling interstices; replacing *pyroxene.*

Titanaugite: about 20% of rock.

Devitrified glass: about 15% of rock; greenish-grey and dark red-brown.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

MICROSLIDE: **GSQ 3671.**

LOCALITY: **Brisbane N.S. 5 (Kuraby),** 177 ft. 1 in.
1-m. Mil. Map: Beenleigh (270731).

MACRO: A massive, fine-grained, black, lustrous rock.

MICRO:

TEXTURE: Hyalo-ophitic, 0·25 to 0·3 mm.

CONSTITUENTS:

Labradorite: about 55% of rock; fresh.

Titanaugite: about 20% of rock; extremely altered to *amphibole.*

Glass: about 25% of rock; yellow; only slightly devitrified.

Opaques: minor.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

EIGHT MILE PLAINS BASALT MEMBER

MICROSLIDE: **GSQ 3107.**

LOCALITY: **Brisbane N.S. 5 (Kuraby),** 84 ft. 7 in.–84 ft. 10 in.
1-m. Mil. Map: Beenleigh (270731).

MACRO: An altered, fine-grained, medium grey rock with abundant amygdales up to 10 mm.

MICRO: Essentially similar to GSQ 3106 except in the following details:—

(1) The grain size of the groundmass of GSQ 3107 is about 0·25 mm.

(2) The percentage of glass in GSQ 3107 is greater than in GSQ 3106.

(3) The entire rock is extremely altered so that the feldspar crystals are almost completely calcitised and the groundmass, in which no other minerals can be recognised, is almost translucent.

(4) No "olivine" phenocrysts occur.

NAME: ALTERED ?OLIVINE BASALT.

MICROSLIDE: **GSQ 3106.**

LOCALITY: **Brisbane N.S. 5 (Kuraby),** 79 ft. 5 in.–79 ft. 7 in.
1-m. Mil. Map: Beenleigh (270731).

MACRO: A massive, fine-grained, dark grey rock with a few irregular, light green amygdales.

MICRO:

TEXTURE: Porphyritic, amygdaloidal; the groundmass is sub-ophitic to hyalo-ophitic, 0·1 to 0·5 mm. The phenocrysts are 1 to 2 mm., subhedral to anhedral.

PHENOCRYSTS:

Serpentine (pseudomorphous after olivine): about 5% of rock.

Labradorite: < 5% of rock; zoned, with schiller structure.

GROUNDMASS:

Labradorite: > 50% of rock; fresh, acicular crystals.

Augite: about 25% of rock; altered in part.

Serpentine: about 5% of rock; pseudomorphous after *olivine.*

Glass: about 10% of rock; dark brown (?devitrified) and green.

Calcite: minor, secondary.

Opaques: minor, associated with glass.

AMYGDALES: *Calcite.*

ORIGIN: Volcanic, extrusive.

NAME: ALTERED OLIVINE BASALT.

MICROSLIDE: **GSQ 3673.**

LOCALITY: **Brisbane N.S. 17 (Capalaba),** 46 ft. 4 in.–46 ft. 9 in.

1-m. Mil. Map: Beenleigh (357831).

MACRO: A massive, fine-grained, grey, amygdaloidal rock.

MICRO: Essentially similar to GSQ 2313.

NAME: BASALT.

MICROSLIDE: * **GSQ 2313.**

LOCALITY: **Old crossing, Tingalpa Creek, Capalaba.**

1-m. Mil. Map: Beenleigh (365835).

MACRO: No specimen available.

MICRO:

TEXTURE: Ophitic to hyalo-ophitic, 0·25 to 1·5 mm.

CONSTITUENTS:

Labradorite: about 65% of rock.

Titanaugite: about 15% of rock; coarse enveloping crystals.

Devitrified glass: about 20% of rock; green.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

TERTIARY BASALT UNDIFFERENTIATED

MICROSLIDE: * **GSQ 3679.**

LOCALITY: **W.P.L. No. 1 (Wellington Point),** 600 ft.–610 ft.

1-m. Mil. Map: Brisbane (421880).

MACRO: No specimen available.

MICRO:

TEXTURE: Ophitic to hyalo-ophitic, 0·5 to 0·75 mm.

CONSTITUENTS:

Labradorite: about 55% of rock; fairly fresh.

Olivine: about 5% of rock; *serpentinised.*

Titanaugite: about 20% of rock.

Devitrified glass: about 20% of rock; with minor associated opaques.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: **GSQ 3678.**

LOCALITY: **W.P.L. No. 1 (Wellington Point),** 80 ft.–90 ft.

1-m. Mil. Map: Brisbane (421880).

MACRO: No specimen available.

MICRO:

TEXTURE: Sub-ophitic and hyalo-ophitic to intersertal, about 0·25 mm.

CONSTITUENTS:

Labradorite: about 65% of rock; fairly fresh.

Olivine: about 5% of rock; pseudomorphed by *iddingsite.*

Titanaugite: about 20% of rock; slightly altered.

Devitrified glass: about 10% of rock; brown, green and yellow with about 5% associated *opaque* microlites.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: **GSQ 3675.**

LOCALITY: **Brisbane N.S. 22 (Ormiston),** 160 ft.

1-m. Mil. Map: Beenleigh (410847).

MACRO: A massive, fine-grained, dark grey rock.

MICRO:

TEXTURE: Porphyritic, the phenocrysts (about 10% of rock) are 0·25 to 5 mm. The groundmass is intersertal, about 0·02 to 0·2 mm.

PHENOCRYSTS:

Olivine: about 10% of rock; pseudomorphed by *serpentine* and *iddingsite.*

GROUNDMASS:

Labradorite: about 50% of rock; fresh, acicular.

Titanaugite: about 20% of rock; granular.

Glass: about 15% of rock; yellow, devitrified in part.

Opaques: about 5% of rock; granular.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

MICROSLIDE: **GSQ 3677.**

LOCALITY: **Brisbane N.S. 21 (Ormiston),** 99 ft. 5 in.–99 ft. 7 in.

1-m. Mil. Map: Beenleigh (414847).

MACRO: A massive, fine-grained, greenish-grey rock.

MICRO:

TEXTURE: Intersertal, about 0·2 mm.

CONSTITUENTS:

Labradorite: about 45% of rock; fresh.

Olivine: about 5% of rock; pseudomorphed by *iddingsite* with *serpentine* or *calcite.*

Devitrified glass: about 20% of rock.

Opaques: about 30% of rock; anhedral, filling interstices.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: **GSQ 3676.**

LOCALITY: **Brisbane N.S. 21 (Ormiston),** 75 ft. 7 in.–75 ft. 9½ in.

1-m. Mil. Map: Beenleigh (414847).

MACRO: A massive, fine-grained, light grey rock.

MICRO:

TEXTURE: Uneven-grained, ophitic to hyalo-ophitic, 0·2 to 1·5 mm. Rare amygdules (about 1·5 mm.) are present.

CONSTITUENTS:

Labradorite: about 55% of rock; fresh.

Olivine: about 10% of rock; pseudomorphed by *serpentine* and *iddingsite.*

Titanaugite: about 20% of rock; fresh.

Devitrified glass: about 15% of rock; green and brown with minor associated *opaque* microlites.

AMYGDULES: *Calcite* with or without a fine outer rim of *devitrified glass.*

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

MICROSLIDE: * **GSQ 3674.**

LOCALITY: **Brisbane N.S. 23 (Manly),** 127 ft. 7 in.–128 ft. 0 in.
1-m. Mil. Map: Brisbane (366907).

MACRO: A massive, fine- to medium-grained, dark grey rock traversed by numerous fine veins.

MICRO: Essentially similar to GSQ 2313 except that the enveloping pyroxene crystals in GSQ 3674 are only about 1 mm. There is no evidence of veining in the thin section.

NAME: BASALT.

MICROSLIDE: * **GSQ 1232.**

LOCALITY: **Fort Lytton.**
1-m. Mil. Map: Brisbane (339963).

MACRO: No specimen available.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 5% of rock) are about 0·02 mm. The groundmass is intersertal, felted about the phenocrysts, about 0·04 mm.

PHENOCRYSTS:

Olivine: about 5% of rock; slightly *serpentinised.*

GROUNDMASS:

Labradorite: about 80% of rock.

Olivine: about 5% of rock.

Devitrified glass: about 5% of rock.

Opaques: about 5% of rock; granular.

ORIGIN: Volcanic, ?extrusive.

NAME: OLIVINE BASALT.

PETRIE FORMATION

MICROSLIDE: * **GSQ 3672.**

LOCALITY: **Brisbane N.S. 19 (Bald Hills),** 660 ft. 6 in.
1-m. Mil. Map: Brisbane (192057).

MACRO: A massive, fine- to medium-grained, light grey igneous rock with abundant yellow altered mafic crystals.

MICRO:

TEXTURE: Uneven-grained, 0·08 to 0·75 mm., sub-ophitic to hyalo-ophitic.

CONSTITUENTS:

Labradorite: about 65% of rock; fresh.

Olivine: about 10% of rock; serpentinised.

Titanaugite: about 10% of rock.

Glass: about 15% of rock; green and brown, devitrified in part with associated *opaque* rods.

ORIGIN: Volcanic, extrusive.

NAME: OLIVINE BASALT.

DESCRIPTION OF PLATE

1. MICROSLIDE: **GSQ 1232** **Tertiary basalt undifferentiated**
   Olivine basalt with anhedral olivine phenocrysts in intersertal groundmass showing crudely felted acicular plagioclase about the large phenocryst.
   Magnification: × 25 Plane Polarised

2. MICROSLIDE: **GSQ 1232** **Tertiary basalt undifferentiated**
   Part of field of (1) above showing abundant granular opaques.
   Magnification: × 50 Plane Polarised

3. MICROSLIDE: **GSQ 3669** **Archerfield Basalt Member**
   Oviline basalt with labradorite phenocrysts in intersertal groundmass.
   Magnification: × 25 Plane Polarised

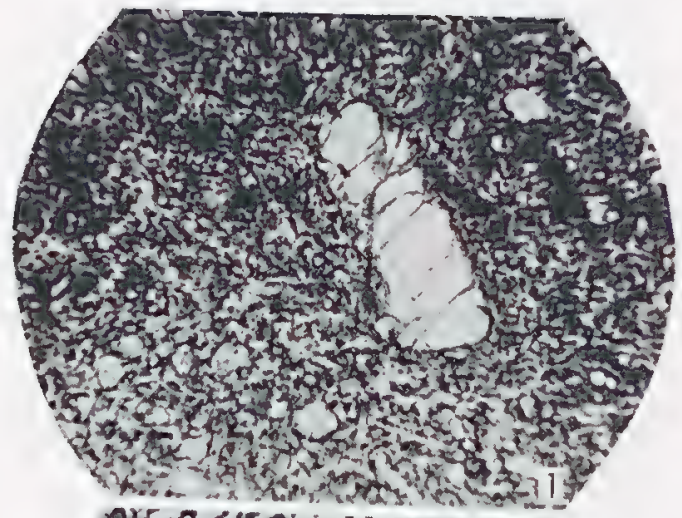
4. MICROSLIDE: **GSQ 3677** **Tertiary basalt undifferentiated**
   Intersertal olivine basalt.
   Magnification: × 25 Plane Polarised

5. MICROSLIDE: **GSQ 3682** **Silkstone Formation**
   Hyalo-ophitic to sub-ophitic olivine basalt.
   Magnification: × 25 Crossed Nicols

6. MICROSLIDE: **GSQ 3666** **Archerfield Basalt Member**
   Sub-ophitic and hyalo-ophitic to intersertal basalt.
   Magnification: × 25 Plane Polarised

7. MICROSLIDE: **GSQ 3666** **Archerfield Basalt Member**
   Ophitic and hyalo-ophitic basalt.
   Magnification: × 50 Plane Polarised

8. MICROSLIDE: **GSQ 3682** **Silkstone Formation**
   Uneven-grained ophitic and hyalo-ophitic olivine basalt.
   Magnification: × 25 Plane Polarised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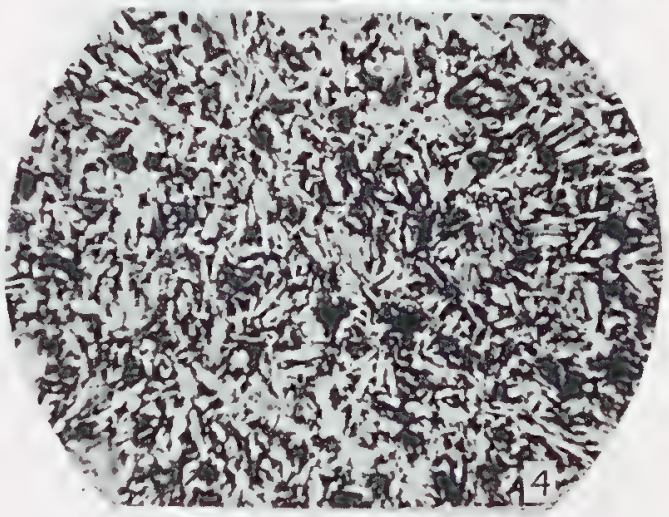
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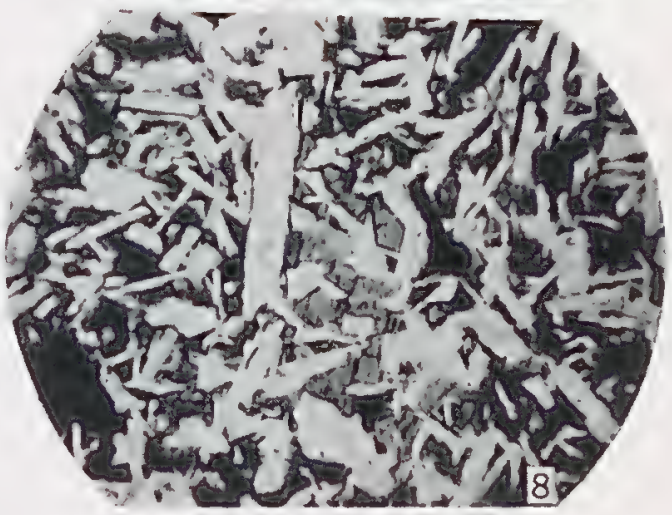
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GEOLOGICAL SURVEY OF QUEENSLAND

(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 327

TRIASSIC VOLCANICS FROM THE BASE OF THE IPSWICH COAL MEASURES, SOUTH-EAST QUEENSLAND

by BEVERLEY R. HOUSTON, B.Sc. (Hons), Geologist

PART I

THE WEIR AND SUGARS BASALTS

PART II

NOTE ON VOLCANICS FROM DEPARTMENTAL DRILLHOLE N.S. 93 (Cooneana Estate)

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PART I

THE WEIR AND SUGARS BASALTS

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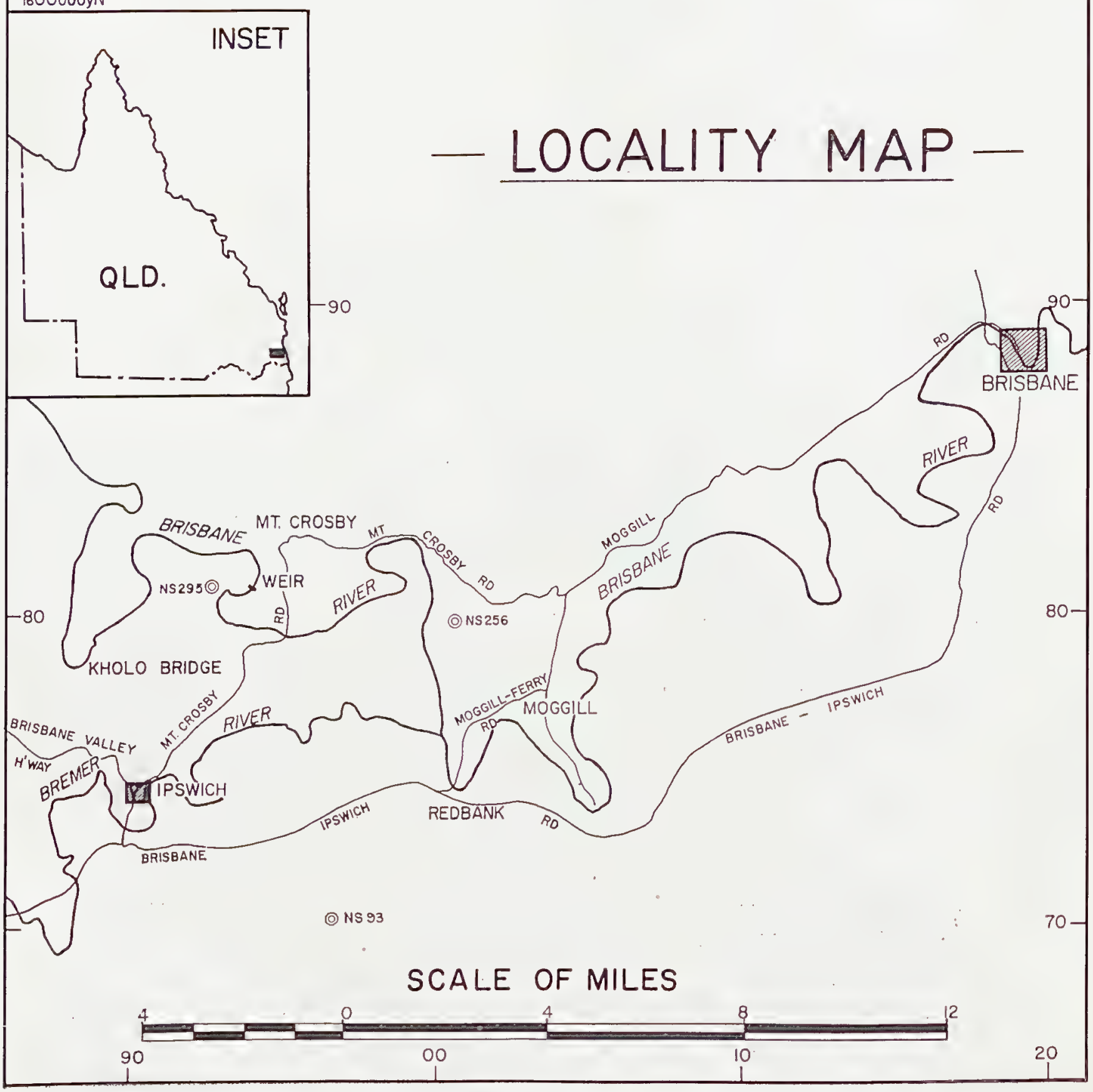
FIGURE 1

— LOCALITY MAP —



PART I

THE WEIR AND SUGARS BASALTS

ABSTRACT

The results of lithologic, petrographic and chemical investigations on cores from two stratigraphic drillholes sunk near the northern margin of the Ipswich basin, South-East Queensland, are discussed.

The Weir and Sugars Basalts, which outcrop in this area, are essentially spilitic in character. On palaeomagnetic and stratigraphic evidence these two units are found to be Triassic in age and are regarded as lateral equivalents, in part at least.

INTRODUCTION

Near the base of the Ipswich Coal Measures (Staines, 1959; Allen, 1959) in South-East Queensland are two volcanic units which have long occasioned interest to local geologists. These are the Weir Basalt (outcropping in the Mt. Crosby area) and the Sugars Basalt (outcropping in the Moggill area) [Fig. 1] which were defined by Allen (1959). In an endeavour to elucidate the stratigraphy and relationships of these units, one diamond drillhole was sunk by the Mines Department at Mt. Crosby and another at Moggill (1964 and 1962).

Historical

Rands (1890) first recorded the presence of basalt at Moggill and Cameron (1899) published a map showing the occurrence of basalts at Moggill and Mt. Crosby; these he described as overlying the Ipswich coal-bearing strata. Cameron (1923) and Jones (1927) described these basalts as Tertiary but Hill (1930), Denmead (1955) and Allen (1959, 1961) favoured a Triassic age.

Allen (1959) gave the names Weir Basalt and Sugars Basalt to the basic volcanics outcropping at Mt. Crosby and Moggill respectively. He described the Weir Basalt (Allen, 1961) as being "very near the base of the Kholo Sub-Group and of about the same age as the Blackwall Breccia". The Sugars Basalt was described (Allen, 1959) as lying "unconformably on the Neranleigh–Fernvale Group and . . . overlain by sediments of the Kholo Sub-Group"; Allen (1959) indicated that the Weir and Sugars Basalts might be laterally equivalent.

Acknowledgements

The writer wishes to thank Mr. W. R. Lauder of Victoria University, Wellington, N.Z., who examined some of the microslides of the Sugars Basalt. Dr. N. J. de Jersey and Mr. R. J. Allen (Geological Survey of Queensland) assisted with discussions on the stratigraphic aspects of the problem. Mr. R. M. Tucker did the photography.

LITHOLOGIC SECTIONS

Generalised lithologic logs of the diamond drillholes sunk at Mt. Crosby (Ipswich N.S. 295) and Moggill (Ipswich N.S. 256) appear in Fig. 2.

Drillhole **N.S. 295 (Mt. Crosby)** [Fig. 1] commenced at the top of the Mt. Crosby Formation and finished in the Neranleigh–Fernvale "Group", thus giving sections of the Mt. Crosby Formation, Weir Basalt and Blackwall Breccia at that point.

Ipswich **N.S. 256 (Moggill)** [Fig. 1] commenced in the Cainozoic Witty Gravel (Houston, 1965) and penetrated Mesozoic sediments before passing into the Sugars Basalt at 78 ft. Due to the limitations of the rig, drilling ceased in basalt at 411 ft.

Mt. Crosby Formation

In the core from N.S. 295 the Mt. Crosby Formation consists dominantly of grey carbonaceous shale with minor light grey crystal tuff; the thickness is about 100 ft. and the beds dip at about 15°. These rocks were not examined microscopically.

The Mesozoic sediments overlying the volcanics in the core from N.S. 256 are about 45 ft. thick and include light grey to greenish-white crystal tuff, decomposed sandstone, mudstone and carbonaceous shale; about 4 ft. of polymictic conglomerate occur at the base. From shale at 41 ft. in the hole, Mr. J. T. Woods (pers. comm.) identified *Cladophlebis* sp., a long range form of no value for correlation purposes. The tuff is extremely altered, acid, with embayed crystals of feldspar (pseudomorphed by secondary green clay minerals) and quartz in an ironstained argillaceous matrix (Microslide GSQ 3736, Appendix I).

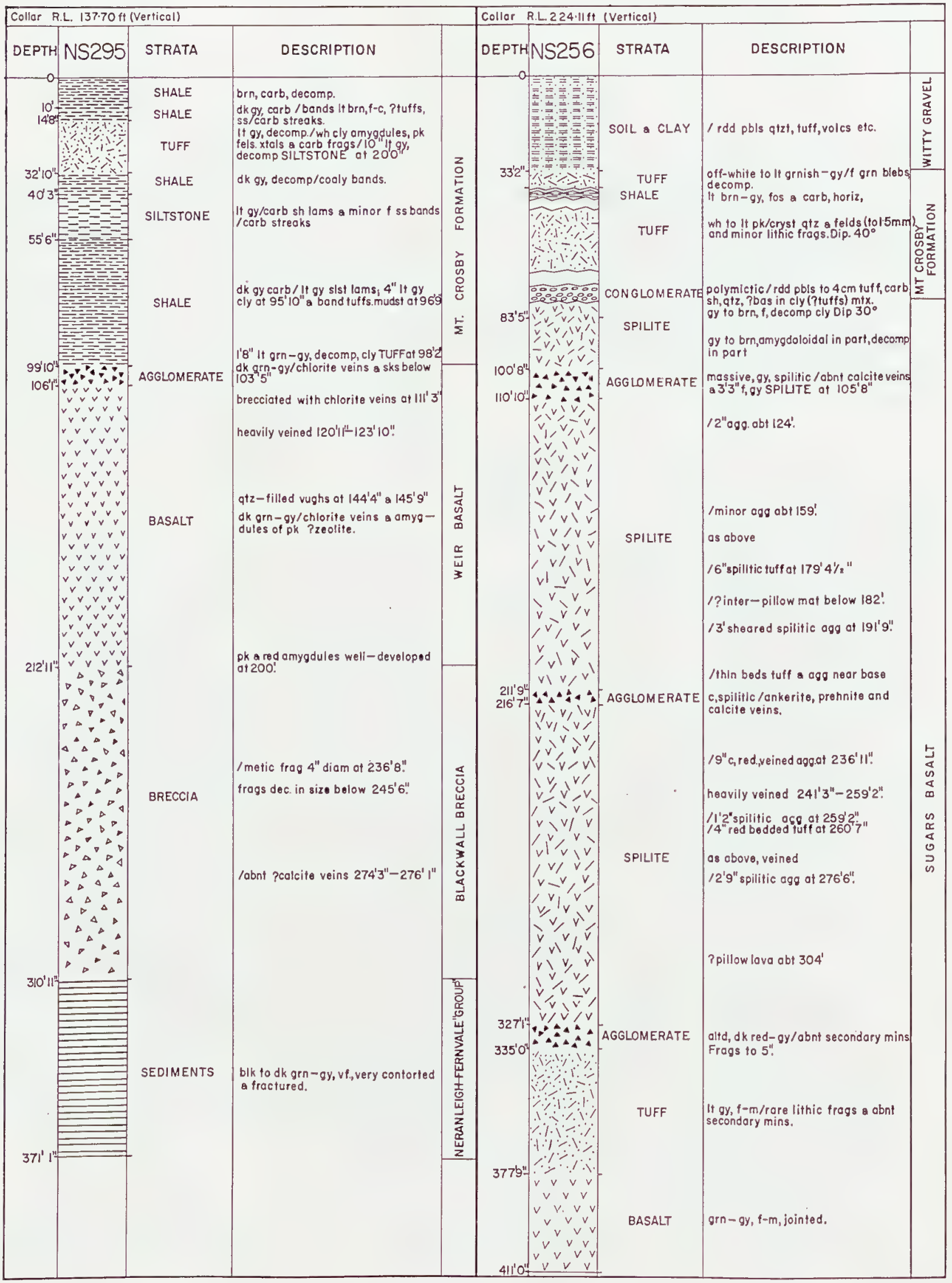
On macroscopic evidence, the writer has little hesitation in correlating this tuff with the tuff occurring in the Mt. Crosby Formation in the type area (Allen, 1961; N.S. 295). Thus, the Mesozoic sediments immediately overlying the Sugars Basalt are tentatively ascribed to the Mt. Crosby Formation.

The Weir and Sugars Basalts are, therefore, both directly overlain by the Mt. Crosby Formation. As the tops of the basalts are somewhat decomposed, it is apparent that the overlying sediments are disconformable.

Weir Basalt

Allen (1961) described the outcropping Weir Basalt as consisting of labradorite, chlorite, opaques and, rarely, pyroxene with serpentinised olivine occurring in some specimens.

FIGURE 2.


Collar R.L. 137·70 ft (Vertical)
DEPTH
NS295
STRATA
DESCRIPTION
10'
14'8"
32'10"
40'3"
55'6"
99'10"
106'1"
212'11"
310'11"
371'1"
SHALE
brn, carb, decomp.
SHALE
dk gy, carb / bands lt brn, f-c, ?tuffs, ss/carb streaks.
TUFF
lt gy, decomp./wh cly amygdules, pk fels. xtals a carb frags/10" lt gy, decomp SILTSTONE at 200'
SHALE
dk gy, decomp/coaly bands.
SILTSTONE
lt gy/carb sh lams a minor f ss bands /carb streaks
SHALE
dk gy carb / lt gy slst lams; 4" lt gy cly at 95'10" a band tuffs. mudst at 96'9"
1'8" lt grn–gy, decomp, cly TUFF at 98'2"
AGGLOMERATE
dk grn–gy/chlorite veins a sks below 103'5"
brecciated with chlorite veins at 111'3"
heavily veined 120'11"–123'10".
qtz–filled vughs at 144'4" a 145'9"
BASALT
dk grn–gy/chlorite veins a amyg–dules of pk ?zeolite.
pk a red amygdules well–developed at 200'.
/metic frag 4" diam at 236'8".
BRECCIA
frags dec. in size below 245'6".
/abnt ?calcite veins 274'3"–276'1"
SEDIMENTS
blk to dk grn–gy, vf., very contorted a fractured.
MT. CROSBY FORMATION
WEIR BASALT
BLACKWALL BRECCIA
NERANLEIGH-FERNVALE GROUP
Collar R.L. 224·11 ft (Vertical)
DEPTH
NS256
STRATA
DESCRIPTION
33'2"
83'5"
100'8"
110'10"
211'9"
216'7"
327'1"
335'0"
377'9"
411'0"
SOIL a CLAY
/ rdd pbls qtzt, tuff, volcs etc.
TUFF
off-white to lt grnish–gy/f grn blebs, decomp.
SHALE
lt brn–gy, fos a carb, horiz,
TUFF
wh to lt pk/cryst qtz a felds (to 1·5mm) and minor lithic frags. Dip. 40°
CONGLOMERATE
polymictic / rdd pbls to 4cm tuff, carb sh, qtz, ?bas in cly (?tuffs) mtx.
SPILITE
gy to brn, f, decomp cly Dip 30°
gy to brn, amygdaloidal in part, decomp in part
AGGLOMERATE
massive, gy, spilitic / abnt calcite veins a 3'3" f, gy SPILITE at 105'8"
/2" agg. abt 124'.
/minor agg abt 159'.
SPILITE
as above
/6" spilitic tuff at 179'4½"
/?inter–pillow mat below 182'.
/3' sheared spilitic agg at 191'9".
/thin beds tuff a agg near base
AGGLOMERATE
c, spilitic / ankerite, prehnite and calcite veins.
/9" c, red, veined agg at 236'11".
heavily veined 241'3"–259'2".
/1'2" spilitic agg at 259'2".
/4" red bedded tuff at 260'7"
SPILITE
as above, veined
/2'9" spilitic agg at 276'6".
?pillow lava abt 304'
AGGLOMERATE
altd, dk red–gy/abnt secondary mins Frags to 5".
TUFF
lt gy, f–m/rare lithic frags a abnt secondary mins.
BASALT
grn–gy, f–m, jointed.
WITTY GRAVEL
MT CROSBY FORMATION
SUGARS BASALT

In the cored section, the volcanics are predominantly fine-grained, dark grey and crystalline with chlorite veins, zeolite amygdules and quartz-filled vughs occurring at random; minor clastic material (?agglomerate) occurs near the top of the section.

Six specimens of flow rocks from the N.S. 295 core were examined in thin section and descriptions of them appear in Appendix I. They are porphyritic with a fine-grained pilotaxitic to intersertal groundmass (Plate I, 1 and 2) and consist essentially of plagioclase (ranging from labradorite to oligoclase), altered clinopyroxene, secondary ?nontronite, serpentine, epidote and/or calcite. At least some of the serpentine is pseudomorphous after olivine.

Sugars Basalt

In outcrop, the Sugars Basalt is porphyritic and consists of plagioclase, clinopyroxene, serpentine and opaques (oxidised in part).

That part of the unit intersected in N.S. 256 is much more heterogenous than the Weir Basalt from N.S. 295; 333 ft. of volcanics were penetrated, including about 28 ft. of agglomerate (in thin beds of 1 to 5 ft.), 42 ft. of tuff (occurring near the bottom of the drillhole) and 263 ft. of lavas. Above the 42 ft. thick bed of tuff, the lavas are predominantly fine-grained and greenish-grey and are characteristically amygdaloidal and heavily veined. A wide range in the percentage and composition of the amygdules indicates a number of flows.

Petrographic descriptions of 7 specimens of this material appear in Appendix I. One specimen of intercalated tuff was described also (microslide GSQ 3729). The lavas are porphyritic, with a fine-grained pilotaxitic to intersertal or hyalo-ophitic groundmass (Plate I, 3 and 4) and are typically spilitic, consisting essentially of plagioclase (ranging from labradorite to oligoclase), uralitised pyroxene and secondary calcite, ?nontronite, chlorite and ?hydrogrossularite. Complex amygdules (Plate I, 7) are common. Extremely irregular, multi-coloured vein-like masses of secondary material occur at intervals; in microslide GSQ 3732 this material is found to be cryptocrystalline silica, with associated hematite, chlorite and calcite, strongly reminiscent of the "inter-pillow material" occurring in pillow lavas (Plate I, 5 and 6). As the core is a small one (bxm) no pillow structures can be recognised.

Below about 380 ft. in N.S. 256 occurs a fine-grained, green basalt which is (microslide GSQ 3735) very fresh, porphyritic, intersertal to intergranular, and consists of labradorite phenocrysts in a groundmass of andesine, clinopyroxene, ?nontronite and opaques (Plate I, 8).

TABLE I

CHEMICAL ANALYSES

	1	2	3	4	5	6	7	8	9	10	11	12
Unit	Weir Basalt		Sugars Basalt									
Locality *Reference	Drillhole N.S. 295 930813		Drillhole N.S. 256 005790					Average of 92 Spilites (Vallance, 1960)	Average Spilite (Wells, 1923)	Average Spilite (Sundius, 1930)	Average Tholeiitic Magma Type (Kennedy, 1933)	Average Olivine Basalt Magma Type (Kennedy, 1933)
Depth	133′ 6″	200′ 5″	150′ 1″	164′ 3″	179′ 4″	314′	396′ 0½″					
Name (Appendix I)	Spilite GSQ 3699	Spilite GSQ 3697	Spilite GSQ 3726	Spilite GSQ 3728	Tuff GSQ 3729	Spilite GSQ 3733	Basalt GSQ 3735					
SiO_2%	53·6	50·7	48·0	47·8	74·4	51·8	47·6	49·65	46·01	51·22	50	45
Al_2O_3%	17·0	17·1	17·8	..	6·9	19·8	17·6	16·00	15·21	13·66	13	15
Fe_2O_3%	5·8	5·9	6·6	..	4·5	6·0	6·3	3·85	1·35	2·84	13	13
FeO%	3·1	3·2	3·3	..	2·3	3·3	4·2	6·08	8·69	9·20		
CaO%	6·0	6·2	5·3	..	2·3	6·0	9·5	6·62	8·64	6·89	10	9
MgO%	4·5	5·1	5·2	..	2·0	1·3	6·8	5·10	4·18	4·55	5	8
Na_2O%	3·9	4·3	4·3	5·4	0·6	4·3	2·3	4·29	4·97	4·93	2·8	2·5
K_2O%	0·66	0·65	0·84	0·8	0·60	0·65	0·62	1·28	0·34	0·75	1·2	0·5
H_2O^+%	2·0	3·0	4·0	..	3·1	3·7	2·2	3·49	2·48	1·88	..	..
H_2O^-%	0·38	0·44	0·80	..	0·54	0·58	0·38					
TiO_2%	1·72	1·80	1·77	..	0·23	2·32	1·77	1·57	2·21	3·32	..	..
P_2O_5%	0·30	0·53	0·32	..	0·01	0·22	0·22	0·26	0·61	0·29	..	..
CO_2%	1·04	0·94	1·46	..	2·40	0·18	0·33	1·63	4·98	0·94	..	..
MnO%	0·16	0·31	0·25	..	0·17	0·09	0·21	0·15	0·33	0·25	..	..
Totals	100·16	100·17	99·94	..	100·05	100·24	100·03	..	..	..	..	..

Analyses 1–7: C. H. Couper, Government Chemical Laboratory, Brisbane (1965).
*Reference to Military Map No. 192 Ipswich, One Mile Series. Second Edition.

Chemical Analyses

The results of chemical analyses of two samples of the **Weir Basalt** and four of the **Sugars Basalt** appear in Table I together with three analyses of typical spilites (Vallance, 1960) and the tholeiitic and olivine basalt magma types of Kennedy (1933).

It is evident from the chemical and mineralogical features that 1–4 and 6 (Table I) are spilites whereas 7 is a typical basalt. The spilites of the Weir and Sugars Basalts show only minor variation except in the very high ratio (>7) of total iron (as Fe_2O_3) to MgO in No. 6 compared with about 2 for the rest. Analysis 5 is of a very fine-grained, thinly-bedded tuff intercalated in the spilite sequence.

Thus, the spilites of the Weir and Sugars Basalts are similar in composition and, except for the variation in the ratio Fe_2O_3/MgO (one sample only) and the presence of intercalated, more acidic pyroclastic material, there is no evidence of differentiation of the parent magma(s).

The presence of fresh basalt at the bottom of the Moggill drillhole is noteworthy but its significance cannot be interpreted with any certainty (p. 4) until a complete section of the Sugars Basalt is available for examination.

Blackwall Breccia

The Weir Basalt in the core from N.S. 295 lies directly on clastic material which, though finer-grained than the typical Blackwall Breccia of Allen (1961), is correlated with the Blackwall Breccia.

On microscopic examination this material was found to be subgreywacke of two alternating types. One type consists predominantly of fragments of basic volcanics similar to the Weir Basalt and quite unlike the known basic volcanics from the Neranleigh–Fernvale "Group" (microslide GSQ 3705); in the second type, clasts of fine-grained metasediments and metavolcanics of the Neranleigh–Fernvale "Group" predominate (microslide GSQ 3703).

Thus, both the Neranleigh–Fernvale "Group" and the Weir Basalt, in part, have contributed detritus to the Blackwall Breccia and the Weir Basalt must have been laterally equivalent, in part, to the Blackwall Breccia.

Near its base in N.S. 295, the Blackwall Breccia is difficult to distinguish macroscopically from the decomposed Neranleigh–Fernvale "Group". At their top, the Neranleigh–Fernvale rocks are heavily veined with calcite, chlorite and prehnite; these minerals decrease in abundance downwards and the veining becomes essentially siliceous. The calcite, chlorite and prehnite appear to have their origin in the Blackwall Breccia and/or the Weir Basalt.

This part of the section was not reached in N.S. 256 so the relationship of the Sugars Basalt to the Blackwall Breccia remains unknown. In outcrop, the basalt appears to have an unconformable relationship with the Neranleigh–Fernvale "Group".

CORRELATION AND AGE

Palaeomagnetic age determinations on outcrop samples from the Weir and Sugars Basalts were carried out at the Australian National University. As a result, Stott (1964) concluded that—

> "(*a*) The Weir Basalt and Sugars Basalt were both magnetised in Triassic time.
>
> (*b*) The Weir Basalt was extruded at a time more than 10^4 years before or after the Sugars Basalt".

Stratigraphically, the Weir Basalt disconformably underlies the Mt. Crosby Formation which de Jersey and Hamilton (1965) believe to have been deposited in the Middle or early Upper Triassic, and overlies (in part) the Blackwall Breccia of unknown age.

The Sugars Basalt, including pyroclastics, underlies apparent equivalents of the Mt. Crosby Formation but its base is not known.

Thus the Weir and Sugars Basalts are not younger than the early Upper Triassic. The writer favours the hypothesis that the extrusion of these basalts was associated with the formation of the Ipswich basin which appears to have taken place in Permian—early Triassic times. The relative positions of the basalt and spilite in the Sugars Basalt may bear some relationship to different stages in the evolution of this basin.

The Weir and Sugars Basalts are generally believed to be laterally equivalent. This hypothesis is supported by their stratigraphic positions and their chemical and mineralogical compositions.

CONCLUSIONS

(1) The Weir and Sugars Basalts disconformably underlie the Mt. Crosby Formation and its apparent equivalents respectively.

(2) The Weir Basalt (in part) overlies the Blackwall Breccia; it is also, in part, laterally equivalent to the Blackwall Breccia as the latter is partly derived from the Neranleigh–Fernvale "Group" and partly from the Weir Basalt. The relationship of the Sugars Basalt to the underlying formations is unknown.

(3) The section of the Weir Basalt intersected in N.S. 295 is comparable chemically and mineralogically with the flows of the upper part of the Sugars Basalt intersected in drillhole N.S. 256.

(4) The Weir and Sugars Basalts were deposited in the Triassic; the age difference between samples taken at outcrop from the two units is reported (Stott, 1964) to be more than 10^4 years. The writer believes that this difference is due to the two samples having been taken from relatively different levels in the two units.

(5) The Weir and Sugars Basalts appear to be stratigraphically equivalent and related in origin. Their extrusion is believed to have been associated with the formation of the Ipswich basin.

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APPENDIX I

DETAILED PETROLOGY

MOUNT CROSBY FORMATION

MICROSLIDE: **GSQ 3736.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 46 ft. 9½ in.
1-m. Mil. Map: Ipswich (005790).

MACRO: A light grey, fine-grained argillaceous rock with recognisable quartz crystals and green clay "blebs."

MICRO:

TEXTURE: Extremely altered, clastic; the clasts (about 10%) are subhedral to anhedral, embayed, about 1 mm. The matrix is dense, very fine-grained, translucent.

CLASTS:

Quartz: about 5%; unstrained.

Feldspar: about 5%; entirely pseudomorphed by *clay minerals.*

MATRIX: *Argillaceous:* about 90% of rock; heavily stained.

ORIGIN: Pyroclastic.

NAME: ALTERED ACID CRYSTAL TUFF.

WEIR BASALT

MICROSLIDE: **GSQ 3700.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 117 ft. 3 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, grey porphyritic, igneous rock.

MICRO: Essentially similar to GSQ 3699.

NAME: SPILITE.

MICROSLIDE: **GSQ 3701.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 127 ft. 8 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, grey igneous rock with abundant altered phenocrysts.

MICRO: Essentially similar to GSQ 3699.

NAME: SPILITE.

MICROSLIDE: * **GSQ 3699.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 133 ft. 6 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, pinkish-grey igneous rock with abundant dark phenocrysts.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 10%) are anhedral, 0·5 to 0·75 mm. The groundmass is pilotaxitic to intersertal, about 0·08 mm.

PHENOCRYSTS:

Clinopyroxene: about 10%; commonly pseudomorphed by *? nontronite.*

GROUNDMASS:

Plagioclase: about 50%; extremely altered.

Clinopyroxene: about 25%; commonly pseudomorphed by *? nontronite.*

Chlorite: about 5%; interstitial.

Calcite: about 5%; secondary.

Epidote: about 5%; brown.

Opaques: minor.

ORIGIN: Alteration of a volcanic, extrusive.

NAME: SPILITE.

MICROSLIDE: **GSQ 3698.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 165 ft. 3 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, grey igneous rock with dark phenocrysts (< 1 mm.).

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 10%) are 0·25 to 0·5 mm, anhedral to subhedral. The groundmass is pilotaxitic to intersertal, about 0·12 mm. A granoblastic xenolith, about 5 mm. (grain size microcrystalline to 0·2 mm.), is surrounded by a fine reaction rim.

PHENOCRYSTS:

Clinopyroxene: about 10% of rock; with minor secondary *? nontronite.*

Feldspar: rare, altered.

GROUNDMASS:

Labradorite: about 50% of rock; altered.

Clinopyroxene: $<$ 40%; with abundant associated secondary *? nontronite.*

Epidote: minor.

Opaques: $<$ 5%.

XENOLITH: *Quartz-mica hornfels:* surrounded by a ring of fine, radiating, prismatic *clinopyroxene* crystals.

ORIGIN: Alteration of a volcanic, extrusive.

NAME: SPILITE.

MICROSLIDE: * **GSQ 3697.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 200 ft. 5 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, grey igneous rock with minor fine phenocrysts.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 5%) are subhedral to anhedral, 0·25 to 0·75 mm. The groundmass is intersertal, about 0·02 to 0·1 mm.

PHENOCRYSTS:

Clinopyroxene: about 5% of rock; fractured and *serpentinised* in part. In some instances the crystals are completely pseudomorphed by *serpentine* and *zeolite* with or without minor calcite.

Oligoclase: minor; replaced in part by calcite and/or *sericite.*

* Chemical analysis given in Table 1.

GROUNDMASS:

Andesine and *labradorite:* about 60%; extremely altered.

Epidote: about 5%; brown.

Chlorite: about 5%; green.

?Nontronite: about 25%; green, secondary.

Opaques: minor.

ORIGIN: Alteration of a volcanic, extrusive.

NAME: SPILITE.

MICROSLIDE: **GSQ 3702.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 212 ft. 4 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, grey igneous rock, heavily veined.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 5%), are anhedral, about 0·5 mm. The groundmass is pilotaxitic, about 0·05 mm.

PHENOCRYSTS:

Clinopyroxene: about 5%; commonly altered to *? nontronite.*

GROUNDMASS:

Plagioclase: about 45%; extremely altered.

?Nontronite: about 30%; green.

Epidote: about 10%; brown.

Opaque dust: about 10%.

VEINS: *Calcite.*

ORIGIN: Alteration of a volcanic, extrusive.

NAME: SPILITE.

SUGARS BASALT

MICROSLIDE: * **GSQ 3726.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 150 ft. 1 in.–150 ft. 3 in.
1-m. Mil. Map: Ipswich (005790).

MACRO: A massive, very fine-grained, greenish-grey igneous rock.

MICRO: Extremely altered.

TEXTURE: Porphyritic. The phenocrysts (> 10% of rock) are 0·5 to 1 mm., subhedral to anhedral. The groundmass is crudely pilotaxitic to intersertal, about 0·08 to 0·16 mm.

PHENOCRYSTS:

Andesine (about $An_{3.5}$): about 10% of rock; subhedral to anhedral lath-shaped crystals; in general, replaced in part by secondary *calcite* and/or *sericite.*

Pyroxene: < 5% of rock; anhedra pseudomorphed, in general, by *?nontronite.*

GROUNDMASS:

Plagioclase: > 50% of rock; extremely altered, acicular crystals.

?Nontronite: about 35% of rock; filling interstices of feldspar crystal mesh.

ORIGIN: Volcanic, extrusive; considerable alteration has occurred.

NAME: SPILITE.

MICROSLIDE: **GSQ 3727.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 150 ft. 0 in.–159 ft. 7½ in.
1-m. Mil. Map: Ipswich (005790).

MACRO: Massive material comprising agglomerate passing downwards into extrusive material. The agglomerate consists of irregular, corroded fragments (up to 4 mm.) of volcanic material in a tuffaceous matrix (cf. microslide GSQ 3729). The extrusive is fine-grained with abundant irregular elongate chloritic amygdules.

MICRO:

TEXTURE: The extrusive is extremely altered but appears to be essentially similar to GSQ 3726.

ORIGIN: Volcanic, extrusive underlying pyroclastic; considerable alteration has occurred.

NAME: SPILITE (altered tuff and altered ?basalt).

MICROSLIDE: * **GSQ 3728.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 164 ft. 3 in.–164 ft. 5 in.
1-m. Mil. Map: Ipswich (005790).

MACRO: A massive, fine-grained, pinkish-grey rock containing about 15% complex amygdules (up to 10 mm.).

MICRO: The rock is extremely altered.

TEXTURE: Porphyritic; the phenocrysts (about 15%) are anhedral to subhedral, commonly somewhat embayed, 0·3 to 1·3 mm. (dominantly 0·5 to 1·0 mm.). The groundmass is intersertal, about 0·1 mm.

PHENOCRYSTS:

Feldspar: < 15% of rock; lath-shaped crystals and stout anhedra; *oligoclase* and *alkali feldspar.* The crystals are, in general, replaced by *sericite* and *clay minerals* and/or *calcite.*

Biotite: minor; ragged flakes pseudomorphed by *?actinolite, chlorite* and *opaques.*

Calcite and/or *?nontronite:* < 5% of rock; with associated *opaques* apparently pseudomorphous after unidentified phenocrysts.

GROUNDMASS:

Feldspar: dominant; altered acicular crystals, unoriented.

?Nontronite: abundant, ironstained; filling interstices.

Opaques: abundant, feathery; possibly iron oxides pseudomorphous after *chlorite* and *uralite.*

Calcite: not abundant; secondary.

AMYGDULES: Of three distinct types:—

(1) Core of radiating fibres of green *chlorite* surrounded by a small fringe of *calcite.*

(2) Core of crystalline *calcite* surrounded by a fine ring of radiating *chlorite* fibres. A third (outer) ring is of *calcite.*

(3) Core of crystalline *zeolite* surrounded by a very fine ring of *calcite* then a slightly coarser-grained zone of radiating *zeolite,* a ring of *calcite* and an outer fringe of radiating *chlorite* fibres with minor admixed calcite.

ORIGIN: Volcanic, extrusive; considerable alteration has occurred.

NAME: SPILITE (altered amygdaloidal ? basalt).

MICROSLIDE: * **GSQ 3729.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 179 ft. 4½ in.–179 ft. 7½ in.

1-m. Mil. Map: Ipswich (005790).

MACRO: Massive, fine-grained, irregularly laminated, off-white to green material.

MICRO:

TEXTURE: Crude graded bedding is distinct, the dip being about 40°. Individual beds tend to be lenticular. Overall, the rock contains about 5% clasts (0·005 to 0·02 mm.) in a very fine-grained matrix. The clasts are subangular to rounded, commonly embayed. Irregular cloudy bands parallel the bedding; small irregular, ramose veins also traverse the rock.

CLASTS: *?Feldspar:* about 5% of rock.

MATRIX: *Argillaceous-tuffaceous:* about 95% of rock; minor associated *?carbonaceous* matter occurs also.

SECONDARY MATERIAL: The cloudy bands appear to be of secondary *chloritic* material.

VEINS: *Calcite,* in 2 directions and *zeolite,* crossing the bedding.

ORIGIN: Volcanic, pyroclastic; considerable alteration has occurred.

NAME: TUFF.

MICROSLIDE: **GSQ 3730.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 218 ft. 1½ in.–218 ft. 4 in.

1-m. Mil. Map: Ipswich (005790).

MACRO: Massive, very fine-grained, greenish-grey material with abundant "specks" of secondary calcite distributed at random.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 5% of rock) are subhedral to anhedral, lath-shaped or stout, 0·5 to 1 mm. The groundmass is intersertal to hyalo-ophitic, up to 0·1 mm. Rare irregular amygdules occur and "patches" of secondary calcite (up to 0·6 mm.) are distributed at random.

PHENOCRYSTS:

Andesine: about 5% of rock; altered to *? nontronite, calcite,* &c.

GROUNDMASS:

Plagioclase: about 35% of rock; altered.

Opaques: about 5% of rock; fine, granular.

?Nontronite: about 35% of rock; very cloudy; *epidote* and *uralite* are believed associated.

Devitrified glass: about 5% of rock.

SECONDARY MINERALS:

Calcite: > 5% of rock; irregular "patches" of all sizes.

Calcite and ?nontronite: < 5% of rock; believed replacing pyroxene.

Chlorite and ? uralite: minor, believed replacing pyroxene.

AMYGDULES: *Chloritic:* about 5% of rock; very cloudy.

ORIGIN: Volcanic, extrusive; considerable alteration has occurred.

NAME: SPILITE (altered basalt).

MICROSLIDE: **GSQ 3731.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** approx. 261 ft.

1-m. Mil. Map: Ipswich (005790).

MACRO: Massive, very fine-grained pink-brown material which appears to be bedded.

MICRO: An extremely altered rock consisting of about 40% acicular and (minor) stout *plagioclase* crystals (about 0·01 mm.), oriented at random, in a dense "cement." Minor irregular ?amygdules are present. The plagioclase is partly replaced by *zeolite* and minor *calcite.* The "cement" is dark brown, translucent to opaque, *ferruginous* material, possibly devitrified *glass.* The ?amygdules are of *zeolite* with minor associated *calcite.*

ORIGIN: Extreme alteration of a volcanic extrusive.

NAME: SPILITE (altered ?glassy ?basalt).

MICROSLIDE: **GSQ 3732.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** approx. 304 ft.

1-m. Mil. Map: Ipswich (005790).

MACRO: A massive, fine-grained, greenish-grey, amygdaloidal rock with abundant, coarse, irregular "veins."

MICRO:

TEXTURE: The host rock is amygdaloidal; the amygdules (about 15%) are irregular, 0·5 to 1 mm. The groundmass is intersertal, about 0·01 mm.

CONSTITUENTS:

Plagioclase: about 35% of rock; acicular crystals; *?oligoclase;* commonly pseudomorphed, in part, by secondary minerals.

Secondary minerals: about 45% of rock, filling interstices; including *? nontronite.*

Opaques: about 5% of rock; very finely divided.

AMYGDULES: *? Serpentine.*

"VEINS": "Vein" material includes *cryptocrystalline silica, hematite, chlorite* and minor *calcite.*

ORIGIN: Alteration of volcanic, extrusive material; the vein material is believed to be "inter-pillow material" but this cannot be proved in a drill core.

NAME: SPILITE (altered ?pillow lava).

MICROSLIDES: * **GSQ 3733, 3734.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** approx. 314 ft.

1-m. Mil. Map: Ipswich (005790).

MACRO: A massive, fine-grained, grey-green igneous rock with abundant dark amygdules and fine pink veins.

MICRO:

TEXTURE: Porphyritic, amygdaloidal; the phenocrysts (about 10%) are subhedral, 0·25 to 0·75 mm. The amygdules (about 5%) are irregular, up to 1·5 mm. The groundmass is pilotaxitic, about 0·01 mm. The rock is traversed by fine irregular veins consisting of a fine (about 0·08 mm.) crystal mosaic.

PHENOCRYSTS:

Oligoclase: about 10%; altered.

Mafic mineral: minor; pseudomorphed by *?nontronite* and *?epidote.*

GROUNDMASS:

Plagioclase: about 30% of rock; acicular.

Secondary minerals: about 55% of rock, including *?nontronite* and *?hydrogrossularite.*

AMYGDULES: *Chlorite:* about 5% of rock; pale green.

VEINS: *Zeolite:* with minor associated *chlorite.*

ORIGIN: Volcanic, extrusive; alteration has taken place.

NAME: SPILITE (altered basal).

MICROSLIDE: * **GSQ 3735.**

LOCALITY: **Ipswich N.S. 256 (Moggill),** 396 ft. 0½ in.
1-m. Mil. Map: Ipswich (005790).

MACRO: A massive dark grey, fine-grained igneous rock with minor dark ?phenocrysts to about 1 mm.

MICRO: None of the dark ? phenocrysts seen in the core appear in the microslide.

TEXTURE: Porphyritic; the phenocrysts (about 5%) are subhedral, 1 to 1·5 mm. The groundmass is intersertal to intergranular, 0·02 to 0·25 mm.

PHENOCRYSTS:

Labradorite: about 5% of rock; essentially fresh.

GROUNDMASS:

Andesine: about 70% of rock; fresh.

?Nontronite: about 15% of rock; filling interstices.

Clinopyroxene: about 10% of rock; granular.

Opaques: minor, granular.

ORIGIN: Volcanic, extrusive.

NAME: BASALT.

BLACKWALL BRECCIA

MICROSLIDE: **GSQ 3703.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 214 ft. 10 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A medium- to coarse-grained, greenish-grey, clastic rock.

MICRO:

TEXTURE: Clastic; the clasts (about 90%) are subangular to subrounded, of low sphericity, 3 to 8 mm. The matrix is very fine-grained.

CLASTS: *Lithic material:* about 90% of rock; including (in estimated decreasing order of abundance):—

Mica ? phyllite

Metasediments

Altered *basic volcanics*

Chert

MATRIX: *Argillaceous:* about 10% of rock; micaceous.

ORIGIN: Sedimentary; except for the volcanics, these fragments were derived from the Brisbane Metamorphics; the volcanics were probably derived from the Weir Basalt, in part.

NAME: BRECCIA.

MICROSLIDE: **GSQ 3704.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 219 ft. 6 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, pinkish-grey, clastic rock.

MICRO: Essentially similar to GSQ 3703 except that the grain size is about 0·6 mm.

NAME: SUBGREYWACKE.

MICROSLIDE: **GSQ 3705.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 239 ft. 10 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, greenish-grey rock, traversed by numerous fine ferruginous veins.

MICRO:

TEXTURE: Clastic; the clasts (about 90%) are rounded to subangular, of moderate sphericity, about 0·25 mm. The matrix is very fine-grained, argillaceous.

CLASTS:

Lithic material: about 80% of rock; including:

Altered *basic volcanics*—about 50% of rock.

Low grade *metamorphics*—about 30%.

Feldspar: about 10% of rock; extremely altered.

GROUNDMASS: *Argillaceous:* about 10% of rock; ferruginous in part.

ORIGIN: Sedimentary; derived from ?Weir Basalt and the Brisbane Metamorphics.

NAME: SUBGREYWACKE.

MICROSLIDE: **GSQ 3706.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 282 ft. 9 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine- to medium-grained, greenish-grey, clastic rock traversed by numerous fine pink and green veins.

MICRO: Essentially similar to GSQ 3703 except in the following details:—

(1) The dominant grain size is about 1·5 mm.

(2) About 5% grains of *quartz* and altered *feldspar* are present.

The *veins* are dominantly of *prehnite.*

NAME: SUBGREYWACKE.

MICROSLIDE: **GSQ 3707.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 310 ft. 7 in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, greenish-grey, clastic rock, heavily veined.

MICRO: Essentially similar to GSQ 3705.

The veins are of *calcite* with *chlorite* and *prehnite.*

NAME: SUBGREYWACKE.

MICROSLIDE: **GSQ 3708.**

LOCALITY: **Ipswich N.S. 295 (Mt. Crosby),** 309 ft. 1½ in.
1-m. Mil. Map: Ipswich (930813).

MACRO: A massive, fine-grained, greenish-grey, clastic rock, heavily veined.

MICRO: Essentially similar to GSQ 3705. Rare clasts of ?Neranleigh volcanics are present also.

NAME: SUBGREYWACKE.

DESCRIPTION OF PLATE

1. MICROSLIDE: **GSQ 3698** **Weir Basalt**
   Spilite with anhedral clinopyroxene phenocryst in fine-grained pilotaxitic to intersertal groundmass.
   Magnification: × 25 Plane Polarised.

2. MICROSLIDE: **GSQ 3697** **Weir Basalt**
   Spilite showing clinopyroxene phenocryst in fine-grained intersertal groundmass.
   Magnification: × 25 Plane Polarised.

3. MICROSLIDE: **GSQ 3733** **Sugars Basalt**
   Spilite showing abundant altered subhedral oligoclase phenocrysts in very fine-grained pilotaxitic groundmass.
   Magnification: × 25 Plane Polarised.

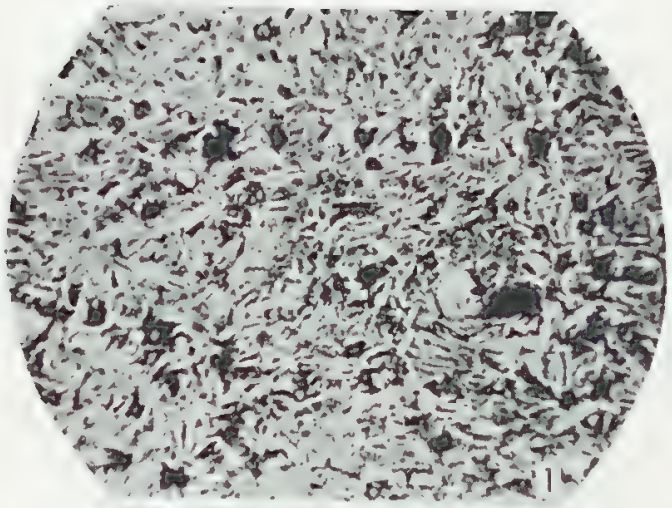
4. MICROSLIDE: **GSQ 3726** **Sugars Basalt**
   Spilite showing subhedral andesine phenocrysts in pilotaxitic to intersertal groundmass.
   Magnification: × 25 Plane Polarised.

5. MICROSLIDE: **GSQ 3732** **Sugars Basalt**
   Spilite (?pillow lava) showing irregular, vein-like bodies of cryptocrystalline silica, hematite, chlorite and calcite (?inter-pillow material) and the relationship to the porphyritic, intersertal spilite (?pillow lava).
   Magnification: × 25 Plane Polarised.

6. MICROSLIDE: **GSQ 3732** **Sugars Basalt**
   Centre of field of (5) above.
   Magnification: × 210 Plane Polarised.

7. MICROSLIDE: **GSQ 3728** **Sugars Basalt**
   Porphyritic, intersertal spilite with zoned amygdules.
   Magnification: × 25 Plane Polarised.

8. MICROSLIDE: **GSQ 3735** **Sugars Basalt**
   Basalt with phenocrysts of labradorite in intersertal to intergranular groundmass.
   Magnification: × 25 Crossed Nicols.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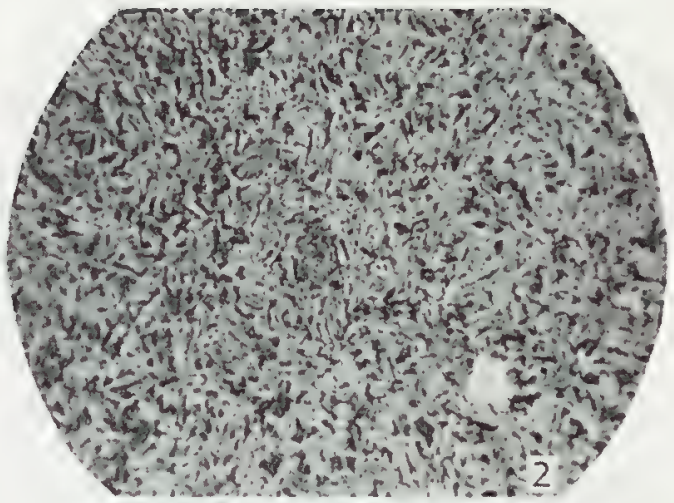
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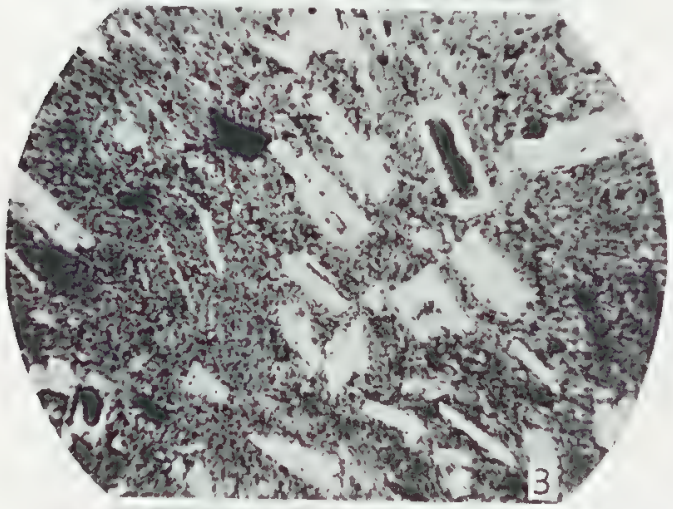
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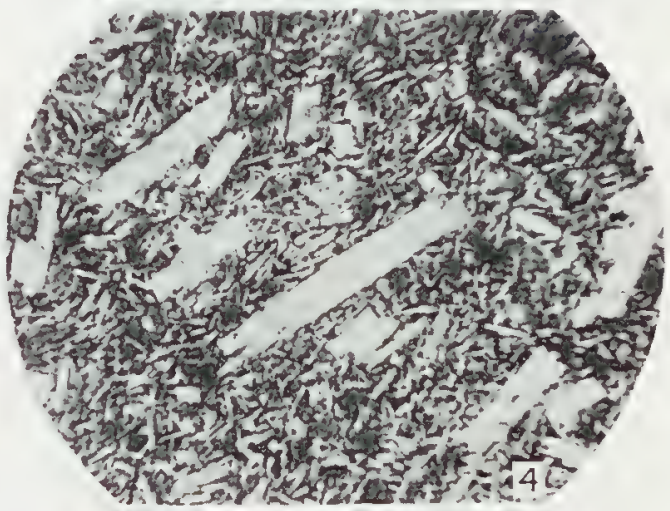
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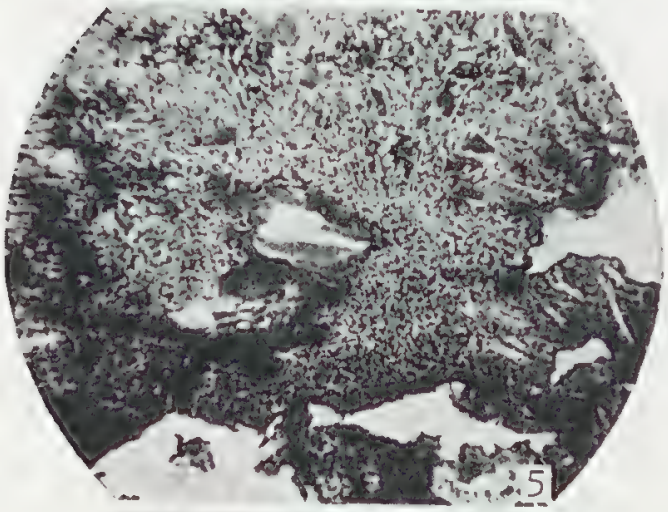
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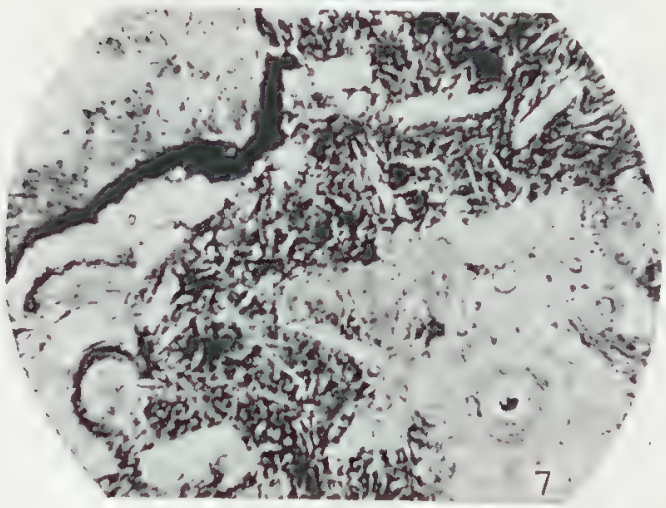
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PART II

NOTE ON VOLCANICS FROM DEPARTMENTAL DRILLHOLE N.S. 93 COONEANA ESTATE

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PART II

NOTE ON VOLCANICS FROM DEPARTMENTAL DRILLHOLE N.S. 93 COONEANA ESTATE

ABSTRACT

Recently prepared chemical analyses and microslide descriptions of specimens of volcanics from Departmental Drillhole N.S. 93 (Cooneana Estate) are presented. Extrusive basalt and trachyte (comparatively rich in soda) are recognised together with tuff and agglomerate.

INTRODUCTION

In 1954, 900 ft. of volcanics were penetrated in drillhole N.S. 93 (Cooneana Estate) [Fig. 1], which was sunk by the Mines Department in the central part of the Ipswich basin (Hawkins, 1956). These volcanics, which occur immediately underlying the Kholo Conglomerate [≡ Colleges Conglomerate of the Kholo Sub-Group of the Ipswich Coal Measures, Allen (1959)], are of considerable interest as they have no known representatives in outcrop and have not, to date, been met in any other drillholes in the basin. The only volcanics known to occur in comparable stratigraphic position in the basin are a rhyolitic tuff in the Mt. Crosby Formation and the Weir and Sugars Basalts (Allen, 1959; Part I, this publication). When the cores obtained from these basalts were being studied, it was decided to re-examine available material from the volcanic section penetrated at Cooneana with a view to finding any possible relationship which might exist between the different units.

PETROLOGY AND CHEMICAL ANALYSES

The examination of the volcanics from N.S. 93 (Cooneana) was, of necessity, brief as few of the cores have been kept. Furthermore, the specimens are of extremely altered rock in which detailed mineral identification is impossible. Petrographic descriptions of nine specimens appear in Appendix I and the results

TABLE I

CHEMICAL ANALYSES

	1	2	3	4	5	6	7	8	9
Locality	Drillhole N.S. 93 (Cooneana Estate) Ipswich 1-mile Mil. Map 967705				Average of 92 Spilites (Vallance, 1960)	Average Spilite (Wells, 1923)	Average Spilite (Sundius, 1930)	Average Tholeiitic Magma Type (Kennedy, 1933)	Average Olivine Basalt Magma Type (Kennedy, 1933)
Depth	2371′ 6″	2628′ 2″	2425′	2535′					
Name Microslide No.	Tuff GSQ 3714	Alkali Trachyte GSQ 3710	Altered ? Basalt GSQ 3712	Altered ? Basalt GSQ 3711					
SiO_2%	60·9	55·1	49·6	57·6	49·65	46·01	51·22	50	45
Al_2O_3%	17·8	18·0	18·0	19·0	16·00	15·21	13·66	13	15
Fe_2O_3%	3·2	5·0	7·5	5·3	3·85	1·35	2·84	13	13
FeO%	0·37	2·6	2·0	2·6	6·08	8·69	9·20		
CaO%	5·2	4·2	4·6	3·4	6·62	8·64	6·89	10	9
MgO%	0·05	2·45	4·9	1·4	5·10	4·18	4·55	5	8
Na_2O%	4·5	5·3	5·4	4·8	4·29	4·97	4·93	2·8	2·5
K_2O%	0·03	1·20	0·32	0·67	1·28	0·34	0·75	1·2	0·5
H_2O+%	5·3	1·25	3·0	1·2	3·49	2·48	1·88	..	..
H_2O-%	0·86	0·53	0·50	0·10					
TiO_2%	0·18	2·46	2·28	1·86	1·57	2·21	3·32	..	..
P_2O_5%	0·06	0·69	0·40	0·45	0·26	0·61	0·29	..	..
CO_2%	0·07	1·08	1·13	1·08	1·63	4·98	0·94	..	..
MnO%	0·06	0·19	0·21	0·18	0·15	0·33	0·25	..	..
Totals	99·58	100·05	99·84	99·64	..	..	..	..	..

Analyses 1–4: C. H. Couper, Government Chemical Laboratory, Brisbane, 1965.

of four chemical analyses carried out at the Government Chemical Laboratory, Brisbane, are given in Table 1. Owing to the alteration, the rock names are based on the combined petrographic and chemical data; the following were determined:—

2197 ft. . .	. . *altered ?trachyte*
2222 ft. . .	. . *altered ?alkali ?trachyte*
2235 ft. . .	. . *altered alkali trachyte*
2329 ft. . .	. . *altered agglomerate*
*2371 ft. 6 in.	. . *tuff*
2383 ft. . . .	. . *altered ?basalt*
*2425 ft. 6 in.	. . *altered ?basalt*
*2535 ft. . .	. . *altered ?basalt*
*2628 ft. 2 in.	. . *altered alkali trachyte*

Hawkins (1956) described the volcanic sequence from Cooneana as consisting of a variety of rocks which could not be identified with any certainty because of the advanced state of alteration of the entire section; he was left with the impression that the sequence was largely tuffaceous with some acid to intermediate volcanic flow rocks present.

Of the material now available for examination, flow rocks (trachyte and ?basalt) are certainly more abundant than pyroclastics. The trachytes are prophyritic with anhedral oligoclase and alkali feldspar phenocrysts occurring in a cryptocrystalline to pilotaxitic groundmass in which feldspar, zeolite, clay minerals and quartz have been recognised. The ?basalts are porphyritic with subhedral to anhedral phenocrysts of plagioclase in a pilotaxitic to intersertal and intergranular groundmass of plagioclase, ?nontronite, epidote and opaques. It is noteworthy that the plagioclase, where identifiable, is andesine or oligoclase, not labradorite. The tuff examined (microslide GSQ 3714) contains clasts which appear similar to the ?basalts but on chemical composition the rock has more acid affinities.

The chemical composition of the ?basalts can be compared with analyses of typical spilites and with the Tholeiitic and Olivine Basalt Magma Types of Kennedy (1933) which are quoted in Table 1 and with the spilites and basalt of the Weir and Sugars Basalts (Part I, Table 1). In making these comparisons the following were noted:—

(1) The CaO/Total alkali ratios of the Cooneana basalts are 0·62 to 0·80 compared with 0·43 to 1·16 for the spilites and 2·5 to 3·17 for the basalt from Moggill and the Magma Types.

(2) The percentages of Na_2O are high and those of K_2O are low compared with the basalts above.

(3) Like the spilites from Mt. Crosby and Moggill, the MgO content is variable; one sample contained 1·4% only.

(4) The comparatively high silica content of sample 3 appears due to the presence of quartz veins.

* Chemical analysis appears on Table 1.

CONCLUSIONS

(1) The volcanic sequence intersected in N.S. 93 (Cooneana Estate) includes altered extrusive trachyte and ?basalt. The samples examined are characteristically alkaline, rich in soda and it is suspected that the basic ones are spilitic. The decomposition of the constituent minerals is too advanced, however, for this to be stated with any certainty.

(2) While the available information is insufficient for a definite conclusion to be reached, the stratigraphic position (Hawkins, 1956) and the sodic (?spilitic) nature of the Cooneana volcanic sequence indicate a possible correlation with the Weir and Sugars Basalts of the Ipswich basin.

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APPENDIX I

MICROSLIDE DESCRIPTIONS OF SPECIMENS OF VOLCANICS FROM DEPARTMENTAL DRILLHOLE N.S. 93 (COONEANA ESTATE)

Ipswich 1-m. Mil. Map 967705

MICROSLIDE: * **GSQ 3710** (2628 ft. 2 in.).
Ipswich 1-m. Mil. Map 967705

MACRO: A massive, fine-grained, porphyritic, purplish-brown, igneous rock.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 5%) are anhedral, about 0·25 to 2 mm. The groundmass is crudely pilotaxitic, extremely altered, about 0·02 mm. About 5% irregular amygdules are present.

PHENOCRYSTS: *Alkali feldspar:* about 5%; *zeolitised.*

GROUNDMASS: Dense, cloudy, including:—
Plagioclase
Zeolite
Clay minerals
Opaques

AMYGDULES: *Zeolite.*

ORIGIN: Volcanic, extrusive.

NAME: ALTERED ALKALI TRACHYTE.

MICROSLIDE: * **GSQ 3711** (2535 ft.).

MACRO: A massive, fine-grained, pinkish-grey igneous rock.

MICRO:

TEXTURE: Porphyritic; phenocrysts are rare, subhedral, about 0·75 mm. The groundmass is pilotaxitic, about 0·04 mm. The rock is heavily veined.

PHENOCRYSTS: *Plagioclase:* rare, altered.

GROUNDMASS:
Oligoclase: about 50%.
?Nontronite: about 25%.
Epidote: about 20%.
Opaques: about 5%.

VEINS: *Calcite, chlorite* and *quartz.*

ORIGIN: Volcanic, extrusive.

NAME: ALTERED ?BASALT.

MICROSLIDE: * **GSQ 3712** (2425 ft. 6 in.).

MACRO: A massive, fine-grained, pinkish-grey, amygdaloidal igneous rock.

MICRO:

TEXTURE: Porphyritic, amygdaloidal; the phenocrysts (about 25%) are subhedral to anhedral, about 0·2 mm. The groundmass is intersertal to intergranular, about 0·01 to 0·05 mm. The amygdules (about 10%) are concentric, about 1 mm.

PHENOCRYSTS: *Andesine:* about 25%; slightly altered.

GROUNDMASS:
Plagioclase: about 30% of rock; altered.
?Nontronite: about 20%.
Epidote: about 20%.
Opaques: about 5%.

AMYGDULES: *Chlorite:* about 10% of rock.

ORIGIN: Extrusive.

NAME: ALTERED ?BASALT.

MICROSLIDE: * **GSQ 3713** (2383 ft.).

MACRO: A massive, fine-grained, pinkish-grey, veined igneous rock.

MICRO: Essentially similar to GSQ 3712 except that amygdules are not abundant and the groundmass is about 0·1 mm.

NAME: ALTERED ?BASALT.

MICROSLIDE: * **GSQ 3714** (2371 ft. 6 in.).

MACRO: A massive, greenish-grey, heavily ironstained rock.

MICRO:

TEXTURE: Clastic; the clasts (about 90%) are rounded, of high to moderate sphericity, dominantly about 2 mm. The interstices are filled with crystalline cement.

CLASTS: *Lithic material:* about 90% of rock; similar to GSQ 3712.

CEMENT: *Secondary minerals* including *epidote, clay minerals* and associated *opaques.*

ORIGIN: Pyroclastic.

NAME: TUFF.

MICROSLIDE: **GSQ 3715** (2329 ft.).

MACRO: A massive, coarse-grained, grey-green clastic rock.

MICRO:

TEXTURE: Clastic; the clasts (about 35%) are embayed, 1 to 20 mm. The matrix is very fine-grained, crudely flow-banded.

CLASTS:
Lithic material: about 30%; volcanic fragments—
basalt
trachyte
rhyolite
Crystals: about 5%; strained *quartz* and altered *feldspar.*

MATRIX: *Argillaceous-tuffaceous:* about 60%; with about 5% secondary *calcite* associated.

ORIGIN: Pyroclastic.

NAME: ALTERED AGGLOMERATE.

---

* Chemical Analysis appears in Table I.

MICROSLIDE: **GSQ 3716** (2235 ft.).

MACRO: A massive, fine-grained, pale pink crystalline rock.

MICRO:

TEXTURE: Porphyritic; the phenocrysts (about 10%) are anhedral, 0·5 to 1·5 mm. The groundmass is microcrystalline to cryptocrystalline. About 20% secondary material is distributed at random.

PHENOCRYSTS: *Feldspar:* about 10%; altered; *oligoclase* and *alkali feldspar.*

GROUNDMASS:

Feldspar: about 65%; extremely altered.

Quartz: about 5%; strained.

Calcite: about 20%; secondary.

ORIGIN: Extrusive.

NAME: ALTERED ALKALI TRACHYTE.

MICROSLIDE: **GSQ 3717** (2222 ft.).

MACRO: A decomposed, fine-grained, light greenish-grey rock.

MICRO: Essentially similar to GSQ 3716 except that:—

(1) Phenocrysts are less abundant.

(2) *Calcite* is not present.

(3) GSQ 3717 is more heavily altered.

NAME: ALTERED ALKALI TRACHYTE.

MICROSLIDE: **GSQ 3718** (2197 ft.).

MACRO: Essentially similar to core from 2222 ft (GSQ 3717).

MICRO: An extremely altered, very fine-grained, feldspathic, volcanic extrusive.

NAME: ALTERED ?TRACHYTE.

S. G. REID, Government Printer, Brisbane

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(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 329

PLANT MICROFOSSILS IN SOME QUEENSLAND CRUDE OIL SAMPLES

By N. J. de JERSEY

BRISBANE
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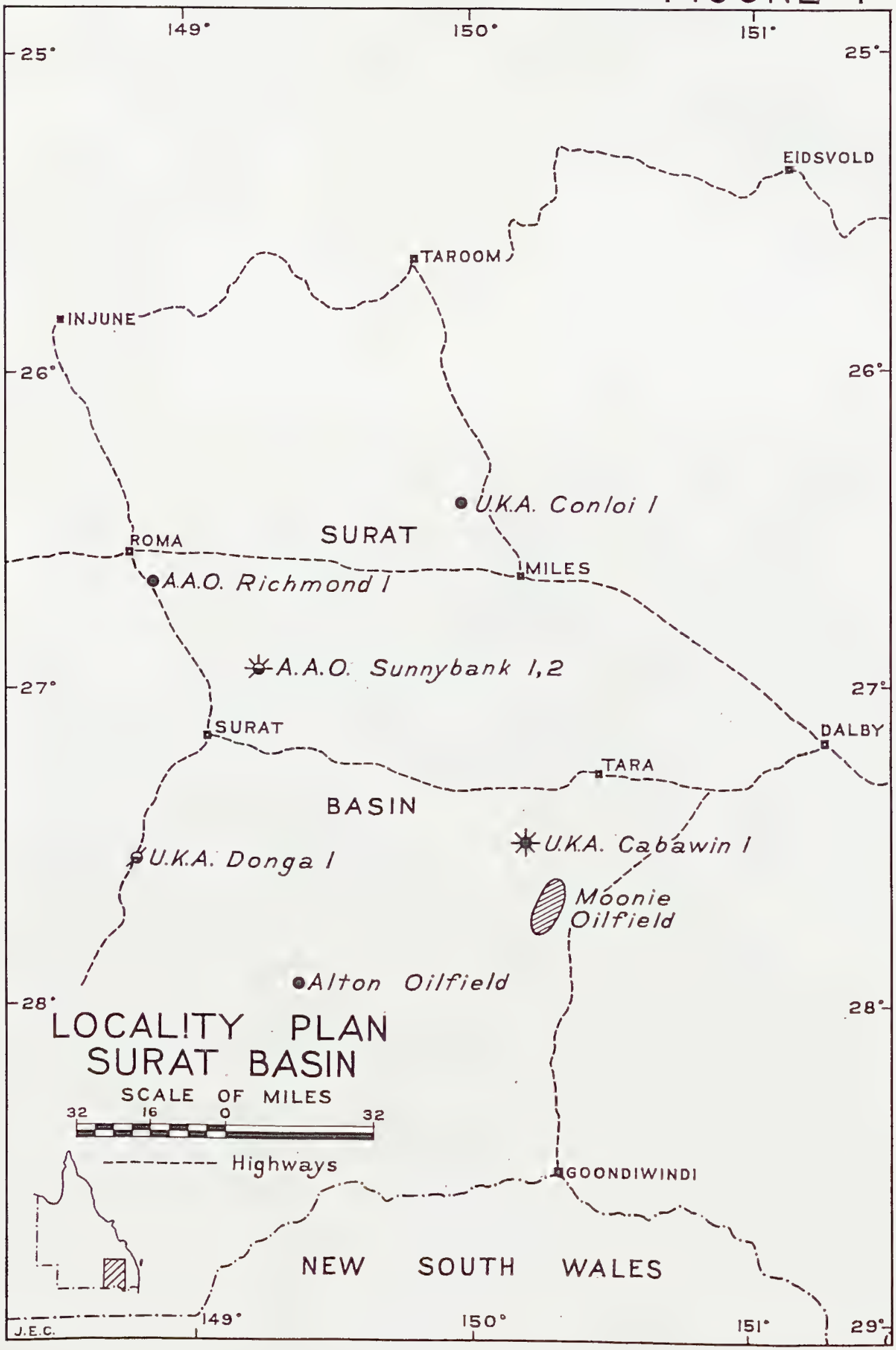
PREFACE

This paper by Dr. de Jersey describes the first recorded investigation of the microfossil content of crude oil carried out in Australia. Microfloral studies, which have been applied effectively by overseas workers in investigating the source and migration of petroleum, have indicated a Jurassic origin for nine representative samples of crude oil from Queensland. This evidence for a Jurassic source for the hydrocarbons necessitates revision of the opinions of some previous authors, who favoured a Permian source. The paper demonstrates the significance of this new approach in study of the source and migration of petroleum in Australia.

A. K. DENMEAD,
Chief Government Geologist.

FIGURE 1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ROMA
MILES
A.A.O. Richmond 1
A.A.O. Sunnybank 1,2
SURAT
DALBY
TARA
BASIN
U.K.A. Cabawin 1
U.K.A. Donga 1
Moonie Oilfield
Alton Oilfield
LOCALITY PLAN
SURAT BASIN
SCALE OF MILES
32 16 0 32
Highways
GOONDIWINDI
NEW SOUTH WALES
J.E.C.

PLANT MICROFOSSILS IN SOME QUEENSLAND CRUDE OIL SAMPLES

by

N. J. DE JERSEY

ABSTRACT

The discovery of plant microfossils, in nine representative samples of crude oil from Queensland, is recorded. Most of the samples came from reservoir rocks of Jurassic age; this group included well-head samples from both of the producing sands of the Moonie oilfield. In addition samples from Triassic and Permian reservoirs have been examined. The microfloral assemblages are in all cases dominated by species characteristic of, or restricted to, the Jurassic of the Surat Basin. Accordingly a Jurassic source is indicated for all the samples in which these assemblages have been found. Within the Jurassic, the evidence points to the Evergreen Shale as the formation containing the principal source beds. It is suggested that the Jurassic sediments may contain the only source of petroleum (in the liquid state) so far discovered in the Surat and Bowen Basins.

1. INTRODUCTION

In a recent paper Horowitz and Langozky (1965) have recorded assemblages of spores and pollen grains, extracted from various hydrocarbon samples from southern Israel. Their samples comprised, in addition to crude oil from the Heletz-Kokhav oilfield, sandstone cores impregnated with crude oil or asphalt, ozokerite from veins and pure asphalt; they were obtained from reservoir rocks of Palaeozoic, Jurassic, Cretaceous and Tertiary age. It was found that all the assemblages contained, and that most were dominated by, Upper Triassic species. Accordingly the authors concluded (1965, pp. 61, 62): "The presence of the same spore and pollen assemblages in hydrocarbons of widely diversified geographical and geological location suggests a common generation and migration history for all the sampled oils. The authors believe that the Triassic spore assemblage points to the Triassic as the source strata".

An investigation of plant microfossils in crude oil samples has also been carried out by Chepikov and Medvedeva (1960), who examined samples from Upper Palaeozoic oilfields in the Ural-Volga region. They likewise concluded that study of the microfloral assemblages in the oil samples was of considerable value in solving problems of the origin and migration of the hydrocarbons.

Accordingly, in view of the significance of the results achieved by these workers, the writer has studied the microfossil content of representative samples of crude oil from Queensland. The principal occurrences of liquid petroleum so far discovered in the State, including those in the Moonie and Alton oilfields, are in reservoir rocks of Lower Jurassic age, in the Surat Basin. In addition, some of the wells drilled in this basin have yielded oil from sediments of Permian and Triassic age, but no commercial production has yet been achieved from pre-Jurassic strata.

Regarding the source beds of the crude oil, two schools of thought have arisen. Some authors, such as Jensen (1926, pp. 80, 91) have noted the proximity of porous sandstones to highly carbonaceous shales within the Jurassic sequence and have favoured these Jurassic shales as a likely source. Others, such as Condit (1935, p. 12) have been impressed by the thickness of the Permian marine sediments known in outcrop to the north of Roma and have believed that the oil migrated from a Permian source into the Jurassic sediments. Mott (1952, p. 860) pointed out difficulties in accepting migration from the marine Permian, as did Moran and Gussow (1963, p. 607), who suggested a Jurassic source for the oil at Moonie.

Further evidence in favour of a Jurassic source was provided by Evans (1962) who discovered microplankton in samples of the Lower Jurassic sediments. He regarded the microplankton (associated with arenaceous foraminifera in one sample) as indicative of a marine environment of deposition for the beds containing them, which he suggested could constitute the source of the hydrocarbons in the Jurassic sandstones. However, in view of the relative thinness of the section containing these microfossils there has been a reluctance on the part of many local geologists to accept a Jurassic origin for the oil occurrences. Thus the most recently published view, that of Traves (1965), still favours the Permian sediments as the main source of the hydrocarbons.

Consequently the principal objective of this palynological investigation has been to obtain evidence which would establish whether the oil was derived from Permian or from Jurassic source beds. To this end a representative series of samples of crude oil, from Jurassic, Triassic and Permian reservoirs, has been examined.

2. SAMPLES EXAMINED

Data on the samples selected for study have been summarised below in Table 1. In addition to particulars of the nature, depths and stratigraphic positions of the samples, the A.P.I. gravities (to the nearest whole unit) are also included. These are considered significant because the densities of the crude oils could influence their capacity to retain spores and pollen grains in suspension.

TABLE 1—SUMMARY OF SAMPLES EXAMINED

Well	Depth	Nature of sample	Reservoir formation	Age	A.P.I. gravity
U.K.A. Conloi No. 1	4313′–4321′	Drill-stem test	Evergreen Shale	Lower Jurassic	29°
U.K.A. Alton No. 7	6206′–6221′	Drill-stem test	Evergreen Shale	Lower Jurassic	50°
U.K.A. Moonie No. 2	5795′–5827′	Production test	Precipice Sandstone	Lower Jurassic	44°
U.K.A. Moonie No. 10	5820′–5832′	Well-head	Precipice Sandstone	Lower Jurassic	44°
U.K.A. Moonie No. 20	5647′–5688′	Well-head	Precipice Sandstone	Lower Jurassic	49°
A.A.O. Richmond No. 1	4005½′–4013′	Production test	Precipice Sandstone	Lower Jurassic	43°
A.A.O. Sunnybank No. 1	5852′–5925′	Drill-stem test	Rewan Formation	Lower Triassic	44°
U.K.A. Donga No. 1	5172′–5236′	Drill-stem test	Wandoan Formation	Triassic	46°
A.A.O. Sunnybank No. 2 ..	6571′–6592′	Drill-stem test	Bandanna Formation	Upper Permian	41°
U.K.A. Cabawin No. 1	9928′–9936′	Production test	Kianga Formation	Upper Permian	49°

The locations of the wells concerned are indicated in the locality map (Figure 1). In Figure 2 are shown the generalised stratigraphic sequences of the wells, from the Hutton Sandstone downwards, together with an indication, for each oil sand, of its position within the sequence.

3. EXPERIMENTAL METHOD

The technique employed by Horowitz and Langozky (1965, p. 59) was followed, with slight modification, in separating microfossils from the Queensland crude oil samples. A volume of about 100 ml. of each sample, was mixed with twice the amount of hot xylol. The solution was then centrifuged at 4000 r.p.m. for 15 minutes, after which the supernatant liquid was poured off. The residue was then washed by centrifuging with xylol at the same speed for a similar period, the washing being repeated until all traces of crude oil were removed. Residues from centrifuging were mounted on microslides without further treatment or staining.

The yield of microfossils from the Queensland samples was of a lower order than the average of those examined by Horowitz and Langozky, who counted an average of slightly less than 200 specimens per sample. Because of this lower yield, a count of 50 specimens was made the objective, in the case of the Queensland samples. To achieve this objective, the average volume of oil processed was of the order of 500 ml. Precautions were taken throughout to prevent contamination from other samples being processed in the laboratory.

The spores and pollen grains were sufficiently well preserved to permit their generic, or even specific, determination, in most cases. Although they were not subjected to oxidation during processing, they were not appreciably darker than exines extracted from the sediments, which had undergone some oxidation, with nitric acid or Schultz solution, to render them suitable for study. In fact, some of the exines had a decidely pale, corroded appearance. It is suggested that prolonged immersion in a medium composed of hydrocarbons may have brought about partial solution of the substance of the spore wall, in such specimens.

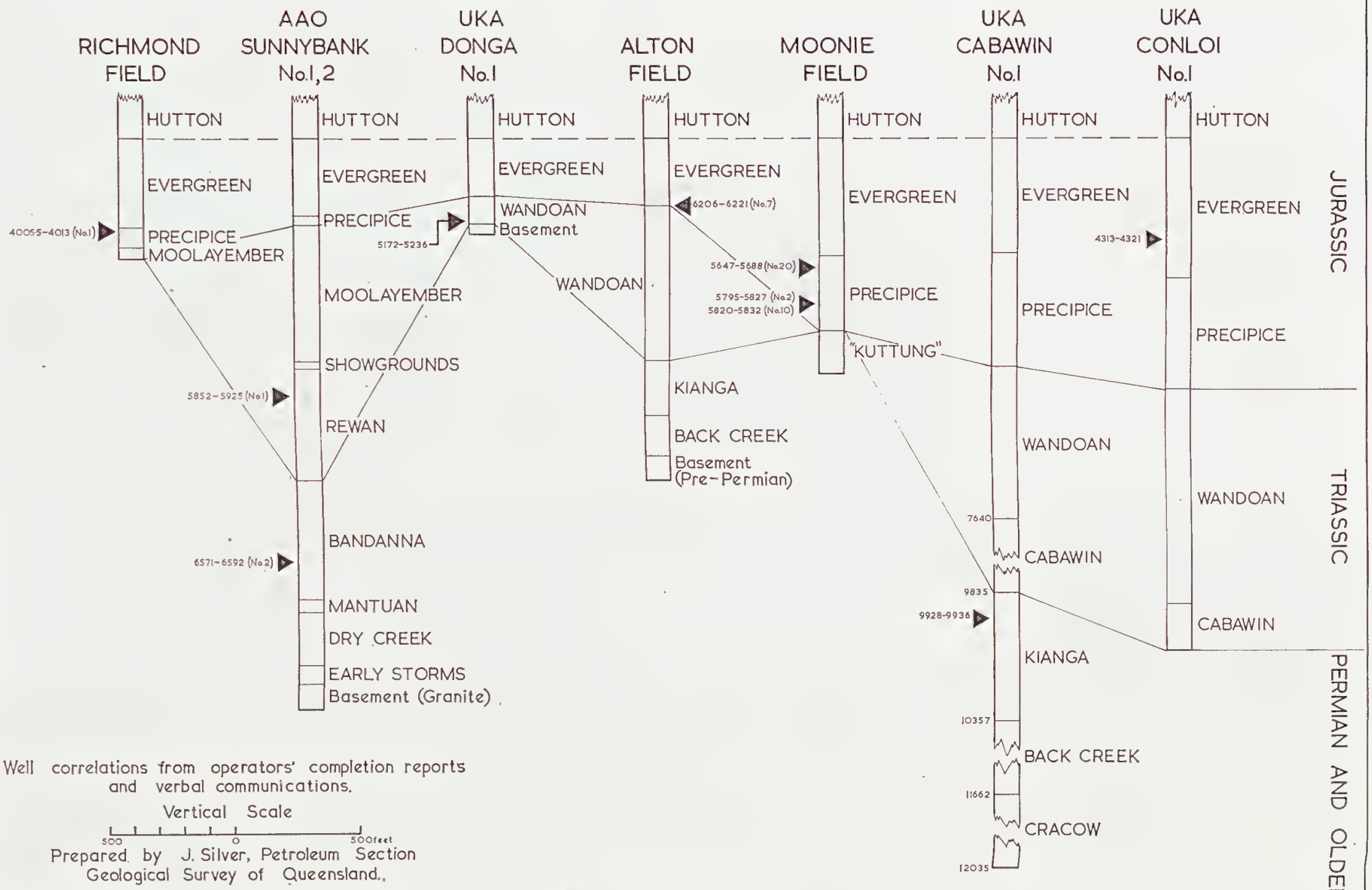
In addition to the spore and pollen exines, the residues from centrifuging contained fragments of other plant tissues, such as leaf cuticles and tracheids. There was also an appreciable proportion of finely divided, indeterminate carbonaceous material, in opaque or translucent particles. In all the samples inorganic material was present, in the form of finely divided particles of clay minerals. The occurrence of siliceous diatom frustules in some of the residues is discussed below under the headings of the relevant samples.

4. MICROFLORAL ASSEMBLAGES

(a) Samples from U.K.A. Moonie Nos. 2, 10 and 20 Wells

The first sample to be examined from the Moonie oilfield was obtained from a bulk sample of a production test of the Moonie No. 2 well, supplied to the Mines Department in the early stages of development of the field. It came from the lower oil sand, from a test of the interval 5795–5827 ft. in this well. A volume of 500 ml. was processed; it yielded the following assemblage:—

	Number of Specimens	Percentage
Classopollis sp.	1	2
Classopollis classoides ..	21	42
Cycadopites nitidus ..	6	12
Granulatisporites sp. ..	1	2
Inaperturopollenites sp. ..	1	2
Leiotriletes sp.	1	2
Leiotriletes directus ..	4	8
Osmundacidites sp.	8	16
Stereisporites sp.	5	10
Vitreisporites pallidus ..	2	4
Totals	50	100



Well correlations from operators' completion reports and verbal communications.

Vertical Scale

500 0 500 feet

Prepared by J. Silver, Petroleum Section
Geological Survey of Queensland.

Depths of oil samples in feet and Well No. shown thus 5647-5688 (No.20)

Arbitrary datum — base of Hutton Sandstone shown thus — — —

Figure 2. Stratigraphic Diagram showing Occurrence of Oil Samples examined.

Although there was no evidence of significant contamination of this sample by drilling mud, it was considered desirable to eliminate this possibility by examining a second, more recently taken, sample. Accordingly, at the writer's request, a well-head sample of crude oil from the lower sand in the Moonie No. 10 well was supplied by the company (the Union Oil Development Corporation). As it was taken in May, 1965, after over a year's production from the well, this sample could be regarded as free from any contamination by drilling mud. In this well the lower sand was present over the interval 5820–5832 ft. The sample (300 ml. processed) yielded the following assemblage:—

	Number of Specimens	Percentage
Classopollis sp. ..	2	3
Classopollis classoides ..	30	51
Coptospora sp.	1	2
Cycadopites nitidus ..	2	3
Granulatisporites sp. ..	1	2
Leiotriletes directus ..	17	28
Leiotriletes sp. nov. ..	1	2
Osmundacidites sp.	1	2
Perinopollenites elatoides ..	2	3
Stereisporites sp.	1	2
?Radiolarian	1	2
Totals	59	100

As well as the forms listed, diatom frustules have been observed in the residue. These are of the same species as that figured from the A.A.O. Sunnybank No. 1 well (Plate 2, Figure 4). Another specimen, probably also of siliceous composition, is of possible Radiolarian affinity, as suggested by Dr. G. Playford (Verbal communication) and is so listed above. Although no detailed taxonomic study of these specimens has been attempted, it is evident that their extraction from the oil samples has indicated a new method for investigating such siliceous microfossils, which would otherwise be difficult to extract from the relatively consolidated sediments of the Surat Basin sequence.

Both of these assemblages are comparable with the microfloras of the Evergreen Shale and the upper part of the Precipice Sandstone, of the Surat Basin. Thus, they are both dominated by *Classopollis,* the remaining elements being all identifiable, or closely comparable, with species known from those formations. In particular, *Coptospora* sp., *Leiotriletes* sp. nov. and *Perinopollenites elatoides* are distinctive species restricted to the Jurassic in Queensland. None of the spores or pollen grains in this count of over 100 specimens, from the two samples, can be identified with a species restricted to the Permian. On the basis of the results of Horowitz and Langozky, an appreciable proportion of Permian species would be expected in the microfloras if the oil had migrated from a Permian source. Consequently the evidence of these assemblages is strongly in favour of a Jurassic origin for the oil in the lower sand at Moonie.

A consideration of the proportions of *Classopollis* in these samples, as compared with percentages of this genus in assemblages from sediments in the Precipice-Evergreen-Hutton sequence, provides a further indication of the source of the hydrocarbons. Detailed study of the distribution of *Classopollis* in this sequence was made by de Jersey and Paten (1964b). The proportions of the genus, determined in assemblages from cores of the Moonie Nos. 1 and 3 wells, are recorded below (Table 2).

TABLE 2—DISTRIBUTION OF *CLASSOPOLLIS,* MOONIE Nos. 1 AND 3 WELLS

Sample	Depth	Percentage of *Classopollis*	Formation
U.K.A. Moonie No. 1, Core 1	4802′	3	Hutton Sandstone
U.K.A. Moonie No. 3, sidewall core	5233′	3	Evergreen Shale
U.K.A. Moonie No. 1, Core 4	5355′	62	
U.K.A. Moonie No. 3, sidewall core	5592′	58	
U.K.A. Moonie No. 3, Core 2	5654′	55	
U.K.A. Moonie No. 3, Core 4	5696′	54	
U.K.A. Moonie No. 3, Core 5	5702′	41	Precipice Sandstone
U.K.A. Moonie No. 3, Core 5	5724′	70	
U.K.A. Moonie No. 3, Core 7	5824′	2	
U.K.A. Moonie No. 3, Core 7	5839′	4	
U.K.A. Moonie No. 3, Core 9	5868′	1	
U.K.A. Moonie No. 3, Core 10	5875′	1	
U.K.A. Moonie No. 3, Core 11	5884′	1	

In the Moonie No. 3 well, the producing interval of the lower oil sand extends over the section from 5835 to 5865 ft. The abundance of *Classopollis* in the assemblages from the crude oil contrasts markedly with the low proportions of the genus in the sediments within, and below, this lower producing sand. There is thus evidence of migration of the oil from the *Classopollis*-rich sediments of the Evergreen Shale or the upper part of the Precipice Sandstone. Such movement, although constituting downward migration in the stratigraphic sense, could also have taken place by lateral movement through the sediments or along the basement contact.

In addition, a well-head sample from the upper sand (5647–5688 ft.) in the Moonie No. 20 well, has been examined. A volume of 100 ml. of this sample was processed; the yield of microfossils was, however, relatively low in comparison with the sample from the lower Moonie sand. Thus on systematic examination of eleven microslides prepared from the

residue, only two specimens, both of *Classopollis classoides,* were observed. It is suggested that this low yield may be related to the lower density of the oil from the upper sand, which may reduce its capacity to retain spores and pollens in suspension. In any case, in view of the evidence put forward above for a Jurassic origin for the oil from the lower sand, a similar source is also favoured for the hydrocarbons in the upper Moonie sand.

(b) Sample from U.K.A. Conloi No. 1 well

The sample from this well, which, with an A.P.I. gravity of 29°, had the highest density of those examined, yielded the following assemblage (from a volume of 800 ml. processed):—

	Number of Specimens	Percentage
cf. *Acanthotriletes* sp.	1	2
Alisporites sp.	2	4
Classopollis sp.	2	4
Classopollis classoides	16	32
Classopollis simplex	2	4
Cycadopites nitidus	1	2
Inaperturopollenites turbatus	1	2
Indusiisporites parvisaccatus	2	4
Leiotriletes directus	4	8
Lycopodiumsporites sp. (de Jersey 1963)	2	4
Osmundacidites sp.	14	28
Perinopollenites elatoides	1	2
Stereisporites sp.	2	4
Totals	50	100

This assemblage, like those from the Moonie samples, is typical of the Lower Jurassic of the Surat Basin, no species restricted to the Permian or Triassic being observed. As in the case of the Moonie samples, a Jurassic source is accordingly indicated.

The crude oil at Conloi came from a thin sand in the lower part of the Evergreen Shale. In general composition, the microfloral assemblage is so typical of that formation that an Evergreen source is favoured for the hydrocarbons. One component of interest is *Inaperturopollenites turbatus.* This species first appears in the upper part of the formation (de Jersey and Paten 1964, p. 11), at an horizon appreciably higher than that of the Conloi sand. Its presence thus favours a downward migration within the Evergreen sequence of at least portion of the oil in this sand.

(c) Sample from A.A.O. Richmond No. 1 well

The sample examined from this well came from a thin sand in the upper part of the Precipice Sandstone. A quantity of 600 ml. was processed; it yielded the following assemblage:—

	Number of Specimens	Percentage
Classopollis classoides	21	49
Classopollis sp.	4	9
Granulatisporites sp.	1	2
Inaperturopollenites reidi	1	2
Leiotriletes directus	8	18
Leiotriletes sp.	1	2
Osmundacidites sp.	3	7
Perinopollenites elatoides	2	4
Punctatisporites sp.	1	2
Stereisporites sp.	2	5
Totals	44	100

This assemblage is also characteristic of the Lower Jurassic, no Permian species having been identified. The Evergreen Shale, which overlies this thin sand at Richmond, is thus again indicated as the source of the hydrocarbons.

The Richmond oil has been selected as representative of several known occurrences of petroleum in the Lower Jurassic sediments of the Roma area. Examples of these occurrences are those in the A.P. Trinidad No. 1 and A.A.O. Anabranch No. 1 wells, the reservoirs sands being in the Precipice Sandstone and Evergreen Shale respectively. By analogy with Richmond, these occurrences are also regarded as likely to be of Jurassic origin.

(d) Sample from U.K.A. Alton No. 7 well

Crude oil from the Alton oilfield is represented by a sample of approximately 150 ml., from the interval 6206–6221 ft. in this well. It yielded the following assemblage:—

	Number of Specimens
Classopollis sp.	1
Classopollis classoides	9
Leiotriletes directus	5
Lycopodiumsporites sp. (de Jersey 1963)	1
Osmundacidites sp.	4
Stereisporites sp.	1
Total	21

This assemblage, like those from the preceding samples, is of typical Jurassic aspect. As well as being dominated by *Classopollis* it contains a distinctive species of *Lycopodiumsporites,* described from the Marburg Sandstone (de Jersey 1963, p. 4) and also observed in assemblages from the Hutton Sandstone and Evergreen Shale of the Surat Basin. In the sequence penetrated by the Alton wells, the oil sands are contained in a section correlated with the Evergreen Shale, the Precipice Sandstone being largely, if not entirely, absent (de Jersey and Hamilton, 1965). Accordingly the fine-grained beds in this Evergreen section are favoured as the source of the hydrocarbons in this oil field.

(e) Samples from A.A.O. Sunnybank Nos. 1 and 2 wells

The sample from the A.A.O. Sunnybank No. 1 well came from a drill-stem test of the interval 5852–5925 ft. This is within the section correlated with the Rewan Formation, of Lower Triassic age. The volume processed was 900 ml.; it yielded the following assemblage:—

	Number of Specimens	Percentage
Alisporites sp. (*Pteruchus*-type)	3	6
Chordasporites sp.	1	2
Classopollis classoides	24	48
Classopollis sp.	2	4
Coptospora sp.	1	2
Cycadopites nitidus	2	4
Granulatisporites sp.	2	4
Leiotriletes directus	7	14
Leiotriletes sp.	1	2
Osmundacidites sp.	5	10
Perinopollenites elatoides	1	2
Bisaccate pollen (indet.)	1	2
Totals	50	100

In addition to the above, one specimen of a diatom (the same species as that found in the assemblage from the Moonie No. 10 sample) was observed.

This assemblage, with its abundance of *Classopollis* (52%) and presence of distinctive Jurassic species, such as *Perinopollenites elatoides* and *Coptospora* sp., is of dominantly Jurassic aspect. It also contains a small proportion of typical Triassic forms, such as *Chordasporites* sp. and *Alisporites* sp. (of the *Pteruchus* type) (Plate 2, Figure 6). The composition of the microflora is thus indicative of migration from a Jurassic source into this Triassic reservoir sand, the Triassic elements being derived from sediments of that age as the oil migrated through part of the Triassic sequence.

The possibility of contamination by drilling mud, leading to the presence of the Jurassic species in the assemblage, has been considered. It seems an unlikely explanation as the drill-stem test, from which the sample came, yielded oil at the rate of 600 barrels per day, a rate of flow likely to remove rapidly any drilling mud adhering to the sand. Furthermore examination of microslides of the residue indicates a relatively low proportion of inorganic material, no greater in amount than that observed in the case of the Moonie well-head samples. If there were significant contamination by drilling mud it should have been detected in this examination of the residue. Finally the composition of the assemblage itself is evidence against such contamination; if contamination had occurred, the resulting microflora would be expected to include diverse microfloral elements from other formations penetrated in the well, instead of this dominantly Evergreen type of assemblage.

Detailed study of the mechanism of migration from a Jurassic source into a Triassic reservoir sand at Sunnybank is beyond the scope of this paper. It seems likely, however, that it could have taken place by downward or lateral movement of the oil through sediments adjacent to the basement contact, followed by lateral migration through the Triassic sediments.

A sample, from the interval 6571-6592 ft. in the A.A.O. Sunnybank No. 2 well, was examined. This sample came from a sand within the Bandanna Formation (Upper Permian). It gave a low yield of microfossils, the following being identified:—

Alisporites sp.
Classopollis classoides (dominant)
Leiotriletes directus
Stereisporites sp.

Because of the low yield, quantitative study was not attempted. The dominance of *Classopollis,* however, gives a Jurassic aspect to the assemblage. Migration from a Jurassic source, as in the case of the sample from the Sunnybank No. 1 well, is thus indicated. A similar path of migration, to that suggested above, may also be invoked to account for movement from a Jurassic source into this Permian reservoir.

(f) Sample from U.K.A. Cabawin No. 1 well

This sample came from the interval 9,928-9,936 ft. It yielded the following assemblage (from a volume of 100 ml. processed):—

	Number of Specimens	Percentage
Annulispora microannulata	1	2
Classopollis sp.	7	14
Classopollis classoides	18	36
cf. *Classopollis* sp.	1	2
Cycadopites nitidus	3	6
Gleicheniidites sp.	1	2
Granulatisporites sp.	1	2
Leiotriletes directus	10	20
Lycopodiumsporites sp. (de Jersey 1963)	1	2
Osmundacidites sp.	3	6
Stereisporites antiquasporites	1	2
Stereisporites sp.	2	4
Striate bisaccate pollen (cf. *Protohaploxypinus sewardi*)	1	2
Totals	50	100

Like those previously recorded, this assemblage is of Jurassic aspect, being dominated by *Classopollis* (50%) and containing typical Jurassic species, such as *Annulispora microannulata, Gleicheniidites* sp. and *Lycopodiumsporites* sp. (de Jersey 1963). As the oil sample was obtained in a production test during which there was an appreciable flow rate (of the order of 50 barrels per day) contamination by drilling mud seems unlikely. This view is supported by the absence of species which characterise higher parts of the sequence, e.g. the Walloon Formation and the Cretaceous sediments, some parts of which, being rich in spores and pollens, would be likely sources of such contamination. Consequently the Jurassic aspect of the assemblage is regarded as indicating migration of the oil into this Upper Permian reservoir from a Jurassic source.

In addition to the Jurassic species, one poorly preserved specimen of striate bisaccate pollen (comparable with *Protohaploxypinus sewardi*), is recorded and figured (Plate 2, Figure 7). It is regarded as having been derived from the Permian sediments containing the reservoir sand. The presence of such a low proportion of Permian species may be due to the consolidated nature of the Permian sediments at the time of migration of the oil; in such a consolidated condition they would be less likely to yield spore and pollen exines to a flow of migrating oil.

As indicated previously, detailed discussion of possible paths of migration of oil from a Jurassic source into pre-Jurassic reservoir rocks is beyond the scope of this paper. It is evident that downward and lateral movement of the hydrocarbons must be postulated; this could take place through the sediments adjacent to the basement unconformity, from where the Jurassic sediments rest on the basement ridge to the east of the Cabawin wells. An alternative path would be downwards and laterally through the Permian sediments from where they are in contact with the Jurassic strata, as for example in the U.K.A. Undulla No. 1 and Tara No. 1 wells, to the north and north-east of Cabawin respectively.

(g) Sample from U.K.A. Donga No. 1 well

The sample examined from this well came from a porous section in the Wandoan Formation (of Triassic age), the interval tested being between 5,172 ft. and 5,236 ft. Several microslides of the residue, from a volume of 100 ml. of the oil, were examined, but no spores or pollen grains were observed, the residue consisting largely of particles of opaque carbonaceous material, together with a smaller proportion of finely divided clay minerals.

Because of the absence of identifiable microfossils, there is no direct evidence on the source of this occurrence of crude oil. By analogy with the oil in the Triassic of the A.A.O. Sunnybank No. 1 well, a Jurassic source could also be suggested in this case.

5. ORIGIN AND MIGRATION OF THE HYDROCARBONS

From the above discussion of individual samples, it is clear that palynological evidence indicates a Jurassic source for all the crude oil occurrences considered. It also indicates that the Evergreen Shale contains the principal source beds, although a minor contribution by the finer sediments of the Precipice Sandstone cannot be completely excluded.

Consideration of the environment of deposition of the Evergreen Shale thus becomes relevant to its potentialities as a source of hydrocarbons. The occurrence of microplankton at horizons in the upper part of the formation favours the view that a marine transgression, or transgressions, took place in this part of the sequence. However, the question which then arises is whether sufficient petroleum could have been generated from the thin beds containing the microplankton to account for the known reserves in the basin. The possibility must be admitted that the whole section (up to about 500 ft.) of the formation could be a source of hydrocarbons. If this is the case, then, as the greater part of the Evergreen Shale, which lacks any marine microfossils, and contains abundant remains of land vegetation, must be regarded as of non-marine origin, a partly, or dominantly non-marine source must be postulated for the oil occurrences. While in the past petroleum geologists have shown some bias in favour of marine sediments as source beds, it is now clear, as indicated by Hedberg (1964, pp. 1772, 1773) that many petroleum deposits are of continental origin. The conclusion that the crude oil of the Surat Basin is, at least partly, of non-marine origin, would thus not represent a new or unique development, when considered in relation to the numerous precedents quoted by Hedberg (*loc. cit.*).

Also implicit in acceptance of an Evergreen source for the samples examined, is acceptance of downward migration of the oil, at least as far as the occurrence in Triassic and Permian reservoirs are concerned. While the presence of oil in sands within the Evergreen Shale, and also in the Precipice Sandstone, may be explained by lateral migration, its presence in a Rewan reservoir, as at Sunnybank, or in the Kianga Formation, as at Cabawin, appears to predicate an additional, downward, component to the movement of the oil. Downward migration of oil is possibly a novel concept in Queensland, where authors have previously favoured upward migration from a Permian source. However the possibility of its occurrence has been accepted by American authors, such as Weeks (1961, pp. 1-50) and Hedberg (1964, p. 1783).

Supporting evidence for a Jurassic origin of the hydrocarbons is provided by application of the "carbon-ratio" theory. This theory has been discussed by many authors. Briefly stated, it utilises the rank of the coals (expressed by a ratio derived from proximate analyses) as an index of their metamorphic evolution. Relatively un-metamorphosed sediments, containing coals with low carbon ratios, are favoured as source and reservoir beds for oil and gas; with increase in the carbon ratios the likelihood of finding liquid petroleum decreases, until the occurrences are confined to gas deposits; finally with more drastic metamorphism the chances of finding any hydrocarbons become remote.

Application of this theory to the Surat and Bowen basins has been discussed by Evans (1963, pp. 14, 15). It is clear that coals from the Jurassic sediments have carbon ratios of the order of 50%, mostly well below the limit of 60%, quoted by Russell (1951), as the value above which the likelihood of oil occurrence falls off rapidly. The carbon ratios of these Jurassic coals are thus in conformity with acceptance of a Jurassic source for the oil of the Surat Basin. For the Permian coals, however, the carbon ratios are all above 60%, indicating a stage of metamorphism sufficiently advanced to preclude, or markedly reduce, the possibility of the sediments now containing petroleum in the liquid state. The marked change in carbon ratios from Jurassic to Permian coals is well

illustrated by the vertical sequence of the U.K.A. Cabawin No. 1 well. In this sequence the Jurassic coals have carbon ratios ranging from 45·9% to 56·8%, while for those in the Permian sediments the ratios are significantly greater (from 66·3% to 70·0%). Accordingly it is evident that application of the carbon ratio theory supports the view that the crude oil in the Permian of the Cabawin well originated from a Jurassic source.

Evans (1963) has extended the principles of the carbon ratio theory to include quality of spore preservation. He has shown that increasing carbon ratio is paralleled by increasing carbonisation and poorer preservation of the spore exines, in samples from the Bowen basin. Thus in the sequence in the Cabawin well, there is a significant decline in quality of preservation of the spores and pollen grains, from Jurassic to Permian assemblages. This difference in preservation will be evident on comparing the photograph of a poorly preserved specimen, comparable with a Permian species, from the Cabawin oil sample (Plate 2, Figure 7) with those of the much better preserved specimens of Jurassic species.

While evidence from the carbon ratio theory is against a Permian origin for the oil of the Surat basin (in conformity with the palynological evidence) it does not exclude a Permian origin for hydrocarbons in the gaseous state. To the north of Roma gas flows have been recorded from Permian sediments in the Rolleston, Westgrove and Glentulloch wells. Although palynological evidence cannot be applied to determine the source of these gaseous hydrocarbons, a Permian source may be more likely, particularly in the case of the Rolleston wells, which were drilled in an area of outcropping Permian sediments. As indicated by Evans (1963, p. 15) Permian coals in this region have carbon ratios between 60% and 70%, i.e. above the limit quoted by Russell (1951) for liquid hydrocarbons, but still below his 70% limit for hydrocarbons in the gaseous condition. A Permian origin for the gas in these wells would accordingly be in conformity with the carbon ratio theory.

In conclusion, although there is ample scope for further investigation of the palynology of crude oil samples, of application of the carbon ratio theory and study of the mechanism of oil migration, in the Surat Basin, the available evidence points towards two simple generalisations. These are:—

(1) That the Permian sediments (underlying the Surat Basin) are unlikely to constitute a source of liquid petroleum, although they could possibly yield gaseous hydrocarbons, and

(2) That the Jurassic sediments contain the only significant source of oil (in the liquid state) so far discovered in the Surat and Bowen Basins.

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EXPLANATION OF PLATES

PLATE 1

(All photographs approximately X1000)

Figure 1.—*Classopollis classoides* (Pflug) Pocock and Jansonius (Richmond No. 1 sample).

Figure 2.—*Perinopollenites elatoides* Couper (Moonie No. 10 sample).

Figure 3.—*Perinopollenites elatoides* Couper (Moonie No. 10 sample).

Figure 4.—*Classopollis classoides* (Pflug) Pocock and Jansonius (Moonie No. 10 sample).

Figure 5.—*Osmundacidites* sp. (Moonie No. 2 sample).

Figure 6.—*Granulatisporites* sp. (Sunnybank No. 1 sample).

Figure 7.—*Classopollis classoides* (Pflug) Pocock and Jansonius (Sunnybank No. 1 sample).

Figure 8.—*Leiotriletes directus* Balme and Hennelly (Moonie No. 2 sample).

Figure 9.—*Coptospora* sp. (Sunnybank No. 1 sample).

Figure 10.—*Inaperturopollenites turbatus* Balme (Conloi No. 1 sample).

Figure 11.—*Cycadopites nitidus* (Balme) de Jersey (Sunnybank No. 1 sample).

Figure 12.—*Lycopodiumsporites* sp. (de Jersey 1963) (Conloi No. 1 sample).

PLATE 2

(All photographs approximately X1000, except where otherwise stated)

Figure 1.—?Radiolarian (Moonie No. 10 sample).

Figure 2.—cf. *Acanthotriletes* sp. (Conloi No. 1 sample).

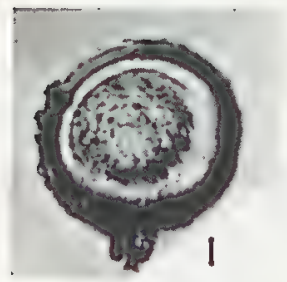
Figure 3.—*Vitreisporites pallidus* (Reissinger) Nilsson (Moonie No. 2 sample).

Figure 4.—Diatom (undetermined) (Sunnybank No. 1 sample).

Figure 5.—*Indusiisporites parvisaccatus* de Jersey (Conloi No. 1 sample).

Figure 6.—*Alisporites* sp. (*Pteruchus* type) (Sunnybank No. 1 sample) X400.

Figure 7.—Striate bisaccate pollen (cf. *Protohaploxypinus sewardi* (Virkki)) (Cabawin No. 1 sample).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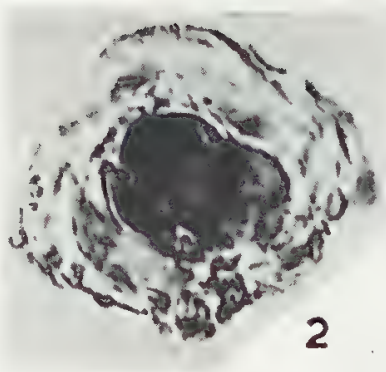
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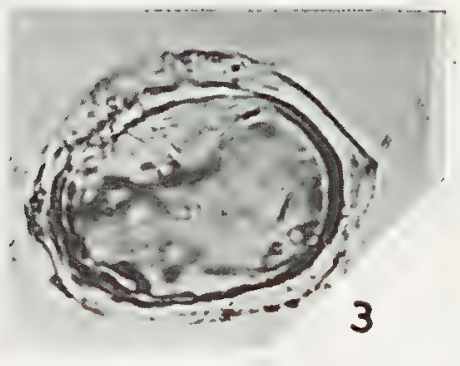
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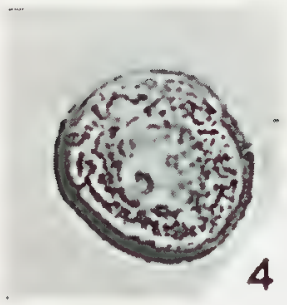
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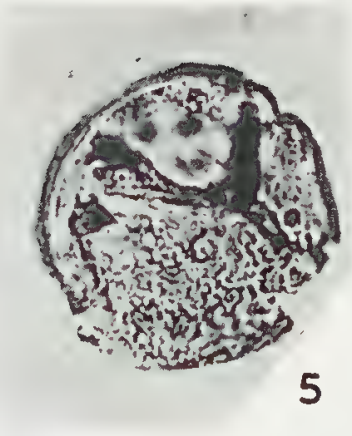
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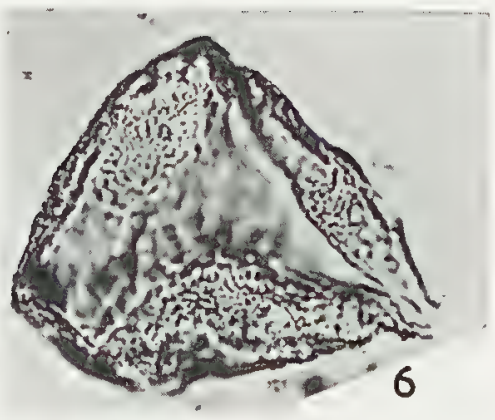
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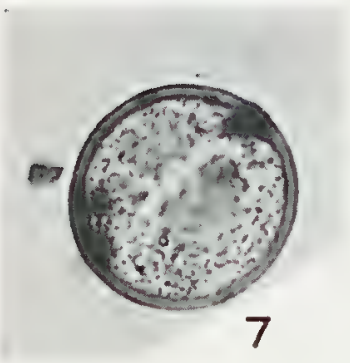
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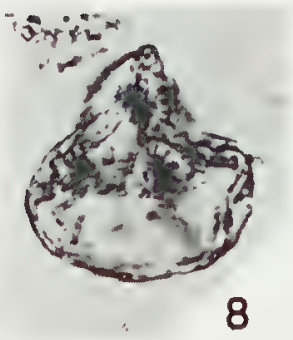
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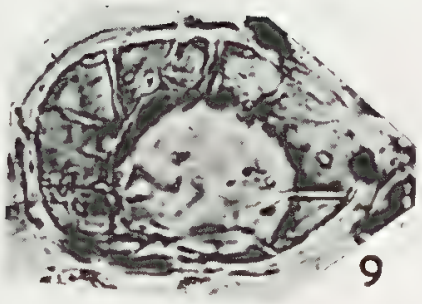
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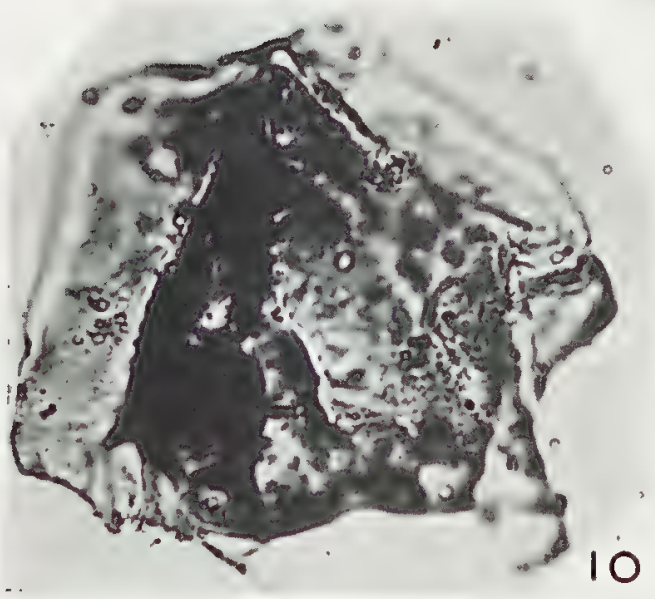
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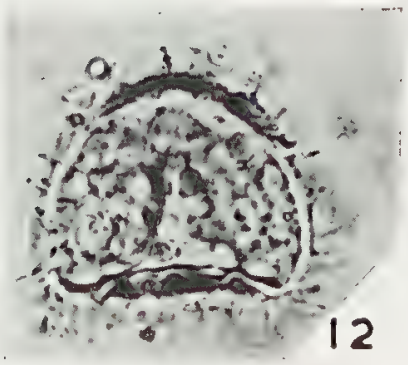
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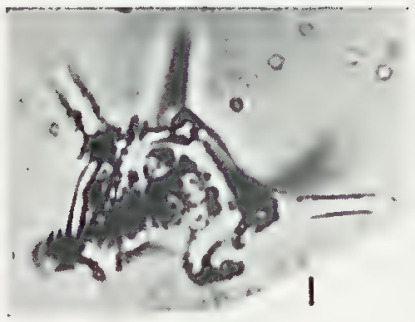
PLATE 1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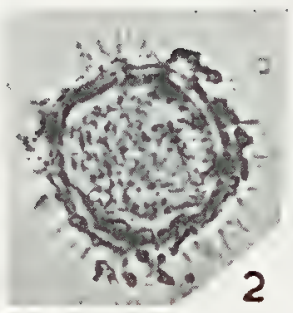
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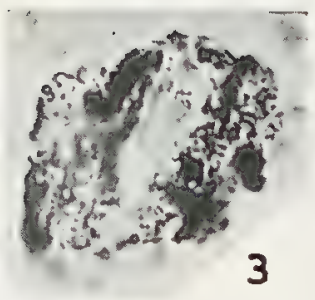
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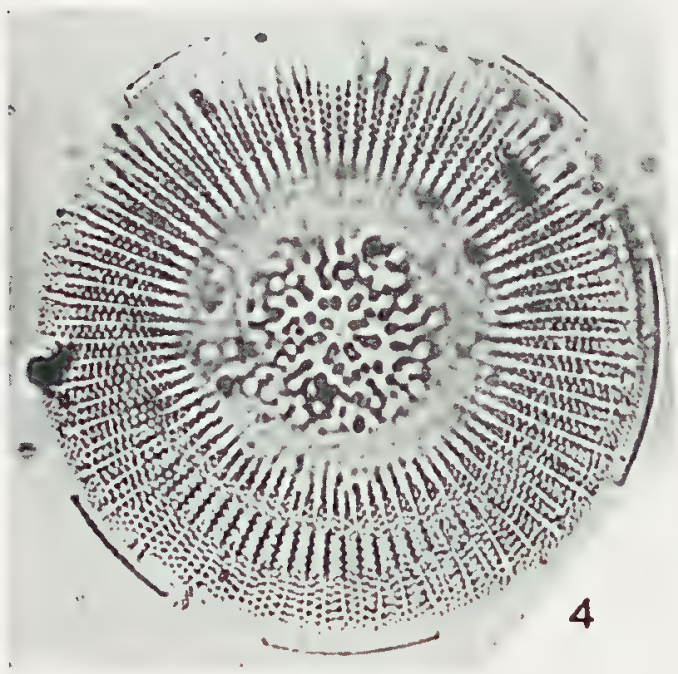
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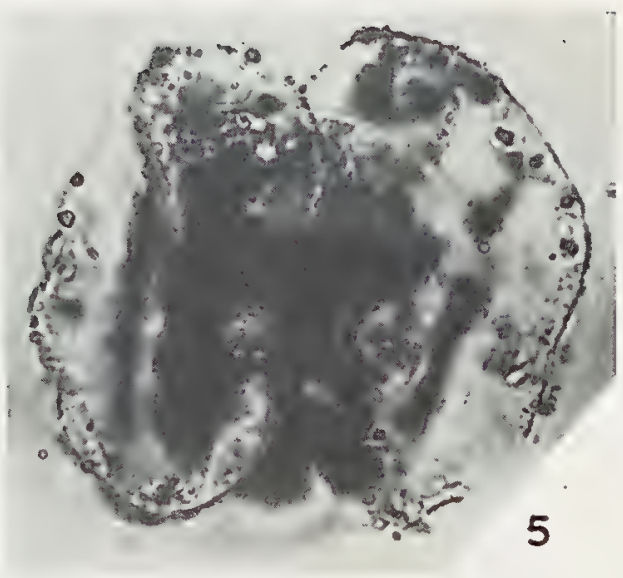
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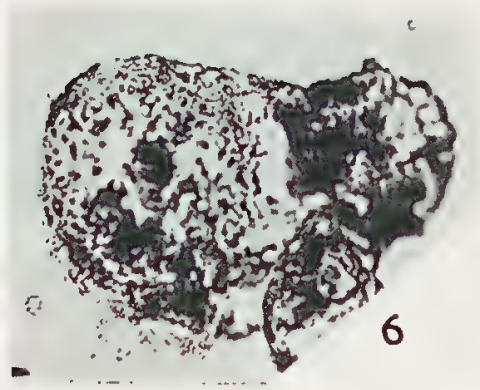
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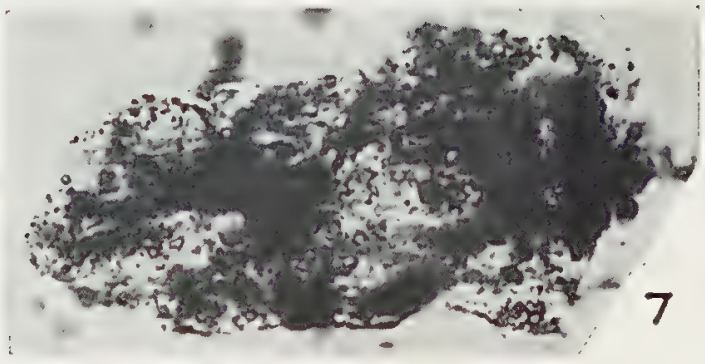
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PLATE 2

APPENDIX—SUMMARY OF SPECIMENS FIGURED

Specimens figured in this paper have been located on the microslides by use of the mechanical stage of a Carl Zeiss (Oberkochen) G.F.L. Microscope. In accordance with the standard practice employed in the Palynology Section of the Geological Survey, the slides have been inserted in the mechanical stage with the labels on the observer's left-hand side; in addition to the stage co-ordinates of each specimen, the co-ordinates of an additional reference point have been determined for each slide. This reference point is, in each case, the corner of the cover glass nearest to the observer, on his right-hand side. These particulars are recorded in the following list for each figured specimen, so that the specimens may be located with the aid of any microscope equipped with a mechanical stage.

Plate reference	Species	Slide No.	Specimen co-ordinates	Co-ordinates of lower right hand corner of cover glass
Plate 1, Figure 1	*Classopollis classoides*	O.D. 2851	43·3, 85·9	47·6, 78·4
Plate 1, Figure 2	*Perinopollenites elatoides*	O.D. 2881	32·9, 93·2	47·3, 86·3
Plate 1, Figure 3	*Perinopollenites elatoides*	O.D. 2906	47·0, 105·5	49·0, 85·1
Plate 1, Figure 4	*Classopollis classoides*	O.D. 2900	37·5, 98·8	46·6, 86·5
Plate 1, Figure 5	*Osmundacidites* sp.	O.D. 2818	34·4, 85·8	46·6, 84·7
Plate 1, Figure 6	*Granulatisporites* sp.	O.D. 2910	41·7, 95·9	47·4, 81·9
Plate 1, Figure 7	*Classopollis classoides*	O.D. 2938	45·0, 85·5	47·8, 83·3
Plate 1, Figure 8	*Leiotriletes directus*	O.D. 2818	29·9, 94·2	46·6, 84·7
Plate 1, Figure 9	*Coptospora* sp.	O.D. 2923	37·6, 92·0	46·6, 81·6
Plate 1, Figure 10	*Inaperturopollenites turbatus*	O.D. 2764	43·2, 84·4	47·8, 83·7
Plate 1, Figure 11	*Cycadopites nitidus*	O.D. 2910	38·9, 89·2	47·4, 81·9
Plate 1, Figure 12	*Lycopodiumsporites* sp.	O.D. 2733	38·1, 84·5	48·0, 83·8
Plate 2, Figure 1	? Radiolarian	O.D. 2891	43·8, 99·5	46·7, 80·6
Plate 2, Figure 2	cf. *Acanthotriletes* sp.	O.D. 2738	30·9, 88·3	47·7, 86·0
Plate 2, Figure 3	*Vitreisporites pallidus*	O.D. 2808	40·1, 93·3	48·0, 74·7
Plate 2, Figure 4	Diatom (undet.)	O.D. 2946	44·7, 94·7	47·6, 85·4
Plate 2, Figure 5	*Indusiisporites parvisaccatus*	O.D. 2766	29·9, 102·5	48·4, 86·9
Plate 2, Figure 6	*Alisporites* sp.	O.D. 2922	35·1, 100·5	47·3, 84·9
Plate 2, Figure 7	Striate bisaccate pollen	O.D. 2975	35·9, 94·5	47·4, 90·4

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QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(J. T. Woods, Chief Government Geologist)

Publication No. 330

THE GEOLOGY OF THE CANIA DISTRICT

NATIONAL MUSEUM OF VICTORIA
13 AUG 1968

by

J. F. DEAR
Geological Survey of Queensland

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THE GEOLOGY OF THE CANIA DISTRICT

ABSTRACT

The stratigraphic succession in the western part of the Yarrol Basin at Cania extends from the Upper Devonian to the Lower Permian, and has a thickness of at least 20,000 feet. The oldest exposed rocks are Frasnian and early Famennian basic volcanics of the Kroombit Beds. They are overlain by clastics and basic volcanics of the Dawes Range Formation, which contains Famennian brachiopod faunas with *Schizophoria, Mesoplica, Sentosia, Cyrtospirifer, Cyrtiopsis, Tenticospirifer, Athyris, Camarotoechia* and *Nayunnella.* Conglomerate, lithic arenite, and andesitic lava, predominate in the lower Tournaisian Three Moon Conglomerate which contains one marine fossil horizon with a brachiopod-molluscan assemblage. The upper Tournaisian Cania Formation comprises lithic arenite, siltstone, conglomerate, and acid and basic volcanics, and is characterized by the development of oolitic limestone at several horizons and by the presence of the brachiopods *Rhipidomella, Schizophoria, Schellwienella, Leptagonia, Rugosochonetes, Pustula, Antiquatonia, Spirifer, Prospira, Brachythyris,* and *Cleiothyridina.* The Lower Permian (Sakmarian) Youlambie Conglomerate rests disconformably on the Cania Formation, and comprises a dominantly terrestrial rudaceous-arenaceous sequence containing plant beds with *Noeggerathiopsis* and marine bands with *Eurydesma.* Rich lower Artinskian faunas occur in the siltstones of the overlying Yarrol Formation and include the brachiopods *Lissochonetes, Strophalosia, Taeniothaerus, Cancrinella, Anidanthus, Terrakea, Neospirifer* (*Grantonia*), *Ingelarella,* and *Psilocamara,* and the goniatite *Uraloceras cancellatum* Dear. Conformably succeeding the Yarrol Formation are the andesitic flows and pyroclastics of the Owl Gully Volcanics which contain scattered marine fossils.

Terrestrial basic volcanics of Triassic age unconformably overlie the folded Yarrol Basin sequence and granite which was emplaced in the Upper Permian. The Jurassic Mulgildie Basin sequence with the Precipice Sandstone equivalent at the base lies unconformably on the Triassic and older rocks.

INTRODUCTION

Cania lies approximately 240 miles north-west of Brisbane in an area where Upper Palaeozoic rocks of the western part of the Yarrol Basin are overlapped by the Jurassic Mulgildie Basin sequence.

Comparatively little geological or palaeontological work had been carried out previously in the area since the time of the earliest geological investigations by W. H. Rands in the 1880's.

A detailed study of the Upper Palaeozoic stratigraphy and palaeontology of the area was initiated as a post-graduate research project, leading to the degree of Doctor of Philosophy, at the University of Queensland during the tenure of a Commonwealth Post-Graduate Award from 1959 to 1961. A doctoral thesis was submitted to the Department of Geology and Mineralogy at the University of Queensland in 1963. Since 1962, geological mapping at Cania and the surrounding districts has been continued as part of the regional mapping programme of the Monto 1:250,000 sheet by the Geological Survey.

Sincere thanks are due to Research Professor D. Hill of the Department of Geology and Mineralogy at the University of Queensland for supervision of the doctoral research project, and to Mr. A. K. Denmead, former Chief Government Geologist, for assistance with the completion of the doctoral thesis after joining the Geological Survey early in 1962.

The region studied covers approximately 130 square miles between latitudes 24° 32′ and 24° 42′ and longitudes 150° 53′ and 151° 04′. It lies within the south-eastern quadrant of the Monto 1:250,000 sheet area and is approximately 20 miles north-west of Monto.

In the late nineteenth century, Cania was an active gold mining centre within the old Cania–Kroombit Goldfield. Scant evidence of the former gold-mining activities remains in the environs of the now deserted township. The region, once with a population of several thousand, is now only sparsley populated, and most of the country is made over to cattle grazing. Access is by gravel road from Monto.

Aerial photo coverage is provided by the 1961 Adastra Monto 1:85,000 set and the 1958 Adastra Lawgi and Many Peaks 1:250,000 series. The base map was compiled by the Drafting Section, Department of Mines, from the 1958 Adastra photography.

Map references throughout the text refer to the 10,000 yard traverse Mercator grid projection of the Monto 4-mile military map. Locality numbers prefixed "L" in the text are found in the University of Queensland Department of Geology and Mineralogy Locality Index; those prefixed "D" refer to the Geological Survey Palaeontology Section Location Index.

The arenite classification followed in the text is that of Crook (1960), which is a modification of that of Packham (1954).

PHYSIOGRAPHY

The Dawes Range in the map area forms part of the watershed separating the Burnett and Fitzroy river systems. Most of the area is drained by Three Moon Creek which joins the Burnett River south of Monto. South Kariboe Creek on the north-western side of the Dawes Range is a tributary of Callide Creek and lies within the Fitzroy drainage-basin.

The pre-Jurassic rocks occupy moderately high ridges deeply incised by numerous creeks and gullies. High sandstone cliffs of the Precipice Sandstone mark the base of the low-dipping Mulgildie Basin sequence. In the south-western part of the map area, the Precipice Sandstone forms an extensive, dissected dip-slope inclined to the south and cut through by the valley of Three Moon Creek. South-east of Spring Creek, the resistant rocks of the Precipice Sandstone have been upturned along the Mulgildie Fault to form a prominent ridge for several miles.

Remnants of a Tertiary basalt capping lie on the older rocks. Post-basalt erosion has been more rapid on the Three Moon Creek side of the Dawes Range than on the South Kariboe Creek side, where the basalt caps are far more extensive and the country much less deeply dissected by the creeks and gullies.

PREVIOUS WORK

The Cania–Kroombit Goldfield dates back to February 1870 when a man later referred to by Rands (1885) as "Greasy Peter" discovered the "Kroombit Diggings" approximately 3 miles north-west of Cania.

In the earliest report on the geology of the area, Rands (1885) described the rocks around Cania as consisting of alternating layers of sandstone, slate, and pisolitic limestone containing marine fossils that he considered of probable Devonian age. Subsequently, Rands (1891) included these rocks in the "Gympie Beds" of "Carbonifero–Permian" age; he also mentioned cappings of "Desert Sandstone" unconformably overlying these Gympie Beds.

Fossils collected by Rands from near Cania township, Hawkins Gully, and Spring Creek were described and figured by Etheridge (1892). The fossils were correlated with those of the Gympie Beds of the "Permo–Carboniferous System".

Reid (1930) included oolitic limestone at Cania in the Lower Carboniferous Rockhampton Series, and correlated the fossiliferous rocks in Spring Creek with the "Permo–Carboniferous Gympie Formation."

Later, Hill (1943) in a correlation table based on coral distribution grouped the oolitic "limestone at Cania" with Viséan oolitic limestones at Lion Creek near Stanwell, and at Riverleigh near Mundubbera.

The distribution of the auriferous lodes and alluvial workings at Cania was discussed in detail by Rands (1885). Ball (1904) reported on a small low-grade iron ore deposit approximately half a mile east of the Cania township. A silver-lead lode in granodiorite at the old Mt. Prospect Mine, south-west of Cania, was the subject of a report by Cameron (1918).

STRATIGRAPHY

SUMMARY

The Yarrol Basin sequence which ranges in age from Upper Devonian to Lower Permian is divided into seven formations, in ascending order—the Kroombit Beds, Dawes Range Formation, Three Moon Conglomerate, Cania Formation, Youlambie Conglomerate, Yarrol Formation and Owl Gully Volcanics. All but the Yarrol Formation and Owl Gully Volcanics (Maxwell, 1959) are new units. A major disconformity separates the Lower Permian Youlambie Conglomerate and the Lower Carboniferous Cania Formation.

Another new stratigraphic unit, the Muncon Volcanics of Triassic age, unconformably overlies the Upper Palaeozoic rocks, and is unconformable beneath the Precipice Sandstone equivalent, the basal unit of the Jurassic Mulgildie Basin sequence.

KROOMBIT BEDS

The Kroombit Beds is a new name proposed for a sequence of basic volcanics and derived clastics, that is overlain by the Famennian Dawes Range Formation near Cania and contains a thick Givetian limestone at its base in Kroombit Creek north-west of the map area (Text-fig. 5). The Beds take their name from Kroombit homestead near Kroombit Creek (m/r 377957 Monto 4-mile military sheet).

The Kroombit Beds crop out extensively in the area between Cania and Kroombit Creek, 8 miles north-west of the north-western corner on the map area. The unit is well exposed around Kroombit Creek eastwards from Kroombit station, along the old track from Kroombit station to Cania, in Allen Creek, and in North Kariboe Creek.

The Kroombit Beds have a minimum thickness of 6,000 feet in the Cania-Kroombit area, but accurate thickness is difficult to estimate because of faulting, and the uniform lithology throughout most of the unit. Up to 3,000 feet of volcanics at the top of the unit are exposed in the map area. The base of the unit has been recognized in only the Kroombit Creek area, and the top has not been identified outside the map area.

In Kroombit Creek, three miles east-south-east of Kroombit homestead, the Kroombit Beds are underlain by an unfossiliferous sequence of laminated siltstone and fine arenite; purplish-weathering conglomerate and coarse-grained arenite with zeolitic and calcareous matrices and cements; and blackish-green basic lava. These sediments and volcanics bear a striking resemblance to many in the lower Tournaisian

Three Moon Conglomerate. A thick grey limestone containing Givetian corals and brachipods is developed at the base of the Kroombit Beds and appears to lie conformably on the older rocks; the limestone actually consists of numerous lenses, interbedded in tough bluish-green basic lavas and pyroclastics, and extending for a vertical thickness of over 1,000 feet. Some limestone lenses containing possible Frasnian corals occur higher in the sequence, and are exposed along the track from Kroombit station to Cania (R. G. McKellar unpub. rep. G.S.Q.).

The middle parts of the unit, well exposed in Allen Creek and North Kariboe Creek, comprise tough green basic lava, agglomerate, tuff, and tuffaceous siltstone.

The topmost 3,000 feet, the only part exposed in the map area, occupy rounded, stoney, strike-ridges, and weather to yield an orange-brown soil; the best exposures are found in Middle Creek, Twelve Mile Creek, and in Langtry Gully. The lithologies are similar to those in Allen Creek and North Kariboe Creek and consist of tough bluish-green basic lava, agglomerate, lapilli, lithic, and ash tuff, and tuffaceous siltstone. Apart from minor purplish volcanic fragments in some of the pyroclastics, purplish lithologies are uncommon in the Kroombit Beds.

Flows dominate the uppermost 3,000 feet of the unit. They are porphyritic and frequently vesicular lavas of basic-andesitic, and less commonly spilitic or basaltic composition. Pillow-lava structures are absent. In the andesites, andesine is the principal feldspar and in the spilites, albite. Fresh pyroxene phenocrysts are rare, but relict phenocrysts of original mafic mineral replaced by a mixture of chlorite, actinolite, epidote, and other minerals are common. Plagioclase, pyroxene, chlorite, epidote, calcite, leucoxene, actinolite and opaque iron oxide occur in the groundmass which has either an intersertal or a pilotaxitic texture. The larger vesicles, in thin-section examination, frequently show an outer rim of fibrous green chlorite, and centres infilled by calcite, zeolite, or chalcedony. Radially-arranged fibrous aggregates of green chlorite occupy many of the smaller vesicles. Granular mosaics of quartz and epidote are seen in thin sections of some vesicles, and in veins.

The coarser pyroclastics comprise angular fragments of green volcanics in a tuffaceous green matrix that is often partly replaced by coarsely crystalline calcite. The ash tuffs and the tuffaceous silstones grade into one another; both show graded-bedding structures.

Thin lenses of unfossiliferous grey limestone, less than 20 inches thick and persisting along strike for a short distance only, occur towards the top of the Kroombit Beds in the Langtry Gully area at m/r 952376 and m/r 955373.

Givetian and probable early Frasnian fossils occur in the lower parts of the Kroombit Beds in the Kroombit Creek area; the remainder of the unit is unfossiliferous. An upper limit to the age of the unit is provided by the brachiopod faunas in the lower part of the Dawes Range Formation, which indicate a lower or early-upper Famennian age.

At least the upper part of the Kroombit Beds are correlated with the Dee Volcanics at Mt. Morgan, which underlie the Boulder Creek Grit, the equivalent at Mt. Morgan of the Dawes Range Formation.

DAWES RANGE FORMATION

Definition. This new name is introduced for the late Upper Devonian sequence of lithic arenite, siltstone, conglomerate, and basic volcanics, that overlies the Kroombit Beds at Cania. The basal part of the unit, consisting of purplish-weathering cross-stratified arenaceous and rudaceous sediments and minor purple-weathering basic volcanics, contrast with the green volcanics of the Kroombit Beds. The Dawes Range Formation is overlain by the lower Tournaisian Three Moon Conglomerate, but the boundary between the two formations is everywhere concealed by faulting in the map area.

The formational name is derived from the Dawes Range.

Outcrop is confined to the structurally complex area north and north-west of Cania, and to the area between the Mulgildie and Kroombit Oaky faults.

Type Section. Principally because of the structural complexity, not one section extending through the whole or even the greater part of the formation was located. The designated type section (Text-fig. 1) is a composite one, embracing the type sections of the four component members which are defined below. The formation has a minimum thickness of 2,700 feet.

Stratigraphic Succession and Members. The Dawes Range Formation is divided into four members which together comprise the whole formation. In ascending order, the members are: the Langtry Gully Member, Milkman Creek Member, South Kariboe Member, and the Denny Gully Member. The Langtry Gully and South Kariboe members comprise essentially clastic sequences that lack the prominent interbedded volcanics of the other two members. In addition, each member has a distinct faunal assemblage.

Langtry Gully Member

Derivation of Name. From Langtry Gully, near Cania township.

Type Section. On the ridge that lies east of Milkman Creek and Langtry Gully. The section comprises two overlapping sections, one extending from the top of the Kroombit Beds at m/r 956373 to m/r 958375 and the other from m/r 944384 to the base of the Milkman Creek Member at m/r 947385. The best exposures are in the type area, in Boolgal Creek, Comet Gully, and adjacent to South Kariboe Creek on the eastern side of the Mulgildie Fault. Thickness in the type section is 620 feet.

Sequence. The lower 220 feet consists of medium and coarse-grained lithic arenite, and granule and pebble conglomerate, in addition to a bed up to 50 feet thick of purple andesitic lava and associated pyroclastics. Medium and fine-grained lithic arenite, and thin interbeds of granule and pebble conglomerate, coarse-grained lithic arenite, and bluish-grey cherty siltstone, make up the remaining 400 feet. Arenites

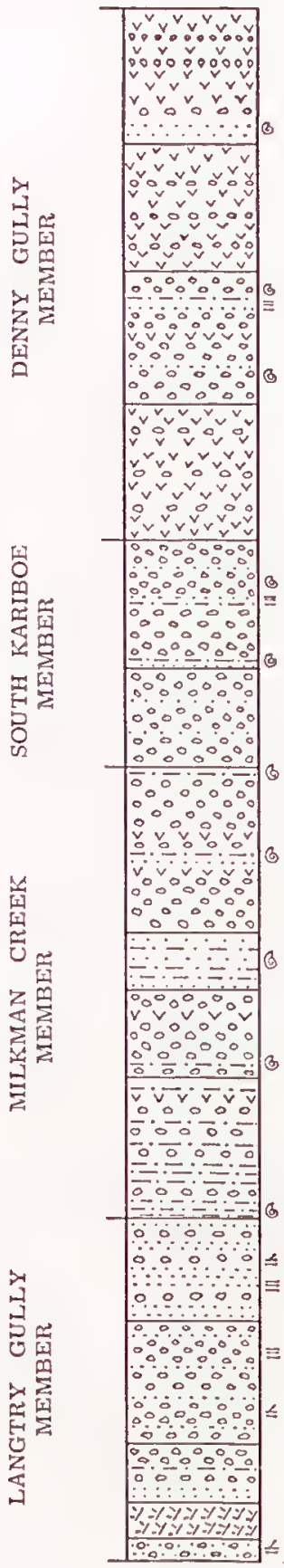
FIG. 1

DAWES RANGE FORMATION

Generalised Stratigraphic Section

based on type sections of component members

Scale 1" = 400'



Green andesitic lava and lapilli tuff; interbedded pebble and granule conglomerate, lithic arenite, and siltstone.

Green andesitic lava, lapilli tuff, and agglomerate; interbedded green pebble and granule conglomerate, lithic arenite and siltstone.

L. 2252

Green calcareous granule and pebble conglomerate, and medium and coarse-grained lithic arenite; interbedded calcareous fine arenite and siltstone, and andesitic lava.

Green andesitic lava, lapilli tuff, and lithic tuff, agglomerate; interbedded green granule and pebble conglomerate.

Green and purple granule conglomerate, medium and coarse lithic arenite; prominent interbedded fossiliferous fine sandstone and blue-grey siltstone.

L. 1994

Green and purple granule conglomerate, medium and coarse lithic arenite calcareous in part; minor pebbly conglomerate.

Green calcareous granule conglomerate and lithic arenite; interbedded pebble conglomerate, blue-green siltstone and green andesitic lava, lapilli tuff, lithic tuff, and agglomerate.

L. 1984

Fine calcareous green arenite and blue-green siltstone with tiny crinoid stems.

Green calcareous granule conglomerate and lithic arenite; interbedded pebble conglomerate, blue-green siltstone, andesitic lava.

Blue-green siltstone with tiny crinoid stems; interbedded green calcareous granule conglomerate, lithic arenite, vesicular andesitic lava, lapilli tuff, lithic tuff, and agglomerate.

L 2232

Medium-fine grained lithic arenite; interbedded granule conglomerate, coarse lithic arenite, siltstone and silicified mudstone.

Granule conglomerate, medium and coarse-grained lithic arenite; interbedded pebble conglomerate, fine arenite, siltstone, silicified mudstone.

Granule and pebble conglomerate, medium and coarse grained lithic arenite.

Purple andesitic lava and lapilli and lithic tuff.
Granule and pebble conglomerate, medium and coarse-grained calcareous lithic arenite.

Marine fossil locality
Cross bedded
Laminated

throughout the Langtry Gully Member are prominently laminated and frequently cross-stratified; siltstones also are frequently finely cross-stratified.

Beds of calcareous lithic arenite crowded with specimens of *Cyrtospirifer* and *Cyrtiopsis* are conspicuous in the upper half of the unit on the eastern side of the Mulgildie Fault and occur in Boolgal Creek, on the ridge south and south-east of Comet Gully, and at several localities near South Kariboe Creek.

The base of the member is marked by a sharp lithological change from the massive green volcanics of the Kroombit Beds to purple-weathering, laminated lithic arenite and pebble and granule conglomerate which contain fragments of purplish or greenish volcanics and feldspar porphyry with large phenocrysts of pink plagioclase.

Milkman Creek Member

Derivation of Name. From Milkman Creek, north-west of Cania.

Type Section. On the crest and eastern slopes of the ridge separating Milkman Creek and the western tributaries of Kroombit Oaky Creek. It comprises two overlapping sections, one extending from the top of the Langtry Gully Member at m/r 947385 to m/r 950386, and the other from m/r 941389 down Anger Gully to the base of the South Kariboe Member at m/r 946388. Thickness in the section is approximately 800 feet. The unit is well exposed in the type area, and around South Kariboe Creek near Hawkins Gully.

Sequence. The lower 250 feet of the unit consists of bluish-green tuffaceous siltstone with interbeds of volcanic conglomerate, tuffaceous lithic arenite and green andesitic lava, agglomerate, and lithic and lapilli tuff. It contrasts with the remaining 550 feet in which pebble and granule volcanic conglomerate, tuffaceous lithic arenite, green andesitic lava and pyroclastics predominate, and the bluish-green siltstones are restricted to isolated sequences.

The base is marked by a sharp change in lithology from purple-weathering arenite on to the bluish-green siltstone and associated green volcanics and volcanic-derived sediments. Purple-weathering lithologies are uncommon throughout the Milkman Creek Member, and the arenites, unlike those in the Langtry Gully and South Kariboe Members, are poorly sorted and almost devoid of stratification. Some of the siltstones and fine-grained arenites are graded bedded. The bluish-green siltstones in the lower part of the unit frequently contain numerous small crinoid stems.

The change into the rocks of the overlying South Kariboe Member is gradational, and the top of the unit is taken immediately above the highest bluish-green siltstone.

South Kariboe Member

Derivation of Name. From South Kariboe Creek, north-west of Cania.

Type Section. In Anger Gully between m/r 946388 and m/r 951388, where a thickness of 370 feet is exposed. Outside of the type section, the unit is well exposed on the Dawes Range west of the Langtry Gully Fault, and east of South Kariboe Creek on the western side of the South Kariboe Fault.

Sequence. The lower half of this member is poorly fossiliferous and consists of medium and coarse-grained lithic arenite, and granule and pebble conglomerate. The upper half comprises similar rocks, with the addition of interbedded bluish-grey or purple fine-grained arenite and siltstone, which contain prolific assemblages of brachiopods, dominated by *Cyrtospirifer.*

Many of the lithologies in the South Kariboe Member are purple-weathering. The arenites are well sorted and prominently laminated but show little cross-stratification.

Interbedded volcanics are absent, and the base of the overlying Denny Gully Member is distinguished by the incoming of green andesitic lavas and pyroclastics.

Denny Gully Member

Derivation of Name. From Denny Gully which flows into South Kariboe Creek, north-west of Cania.

Type Section. The type section is contained in three overlapping sections, one in each of three fault blocks; one near the junction of South Kariboe Creek and German Gully; the second further east in Denny Gully; and the third to the south-east in Fig Tree Creek. The sequence overall becomes progressively younger eastwards with the highest beds in the member exposed in the Fig Tree Creek area. The lowest section extends along South Kariboe Creek and into German Gully, between m/r 905396 and m/r 908392. The middle section extends from South Kariboe Creek at m/r 908397 along the southern slopes of the ridge north of Denny Gully to m/r 925391. The highest section is in Fig Tree Creek and up the ridge to the south, between m/r 933377 and m/r 938377. The thickness in the type area is estimated at a minimum of 900 feet.

Sequence. This member includes thick sequences of interbedded volcanics, and comprises a succession of green andesitic lava, and agglomerate; lithic, lapilli, and ash tuff; pebble and granule volcanic conglomerate; lithic arenite; and tuffaceous siltstone. Lithologies are mostly green and similar to those in the Milkman Creek Member. Except in the proximity of several fossil localities rich in *Cyrtospirifer,* the arenites are tuffaceous, poorly sorted, and not well laminated. Some of the siltstones and fine-grained arenites are graded bedded. The bluish-green siltstones differ from those in the Milkman Creek Member in being developed in thin sequences only, in containing few crinoid stems, and in different faunal content.

Lithology. The conglomerates are composed principally of basic-volcanic fragments, the only major exception being the conglomerates in the Langtry Gully Member which contain numerous pebbles and granules of feldspar porphyry with large pink phenocrysts of oligoclase up to 3 mm. in length. Plutonic and other hypabyssal rock-fragments are rare.

In comparison to the conglomerates in the Milkman Creek and Denny Gully Members, those in the

Langtry Gully and South Kariboe Members have much higher proportions of purplish volcanics to greenish volcanics and have more strongly sorted matrices; several have mineral cements of calcite and chlorite.

Most of the arenites are lithic labile, in the terminology of Crook (1960). Feldspar is subordinate to lithic grains; quartz is virtually absent; and fine matrix rarely exceeds 20 per cent. The associated sedimentary structures in the Langtry Gully and South Kariboe Members reflect traction-current activity, but the graded-bedded siltstones and fine arenites in the other two members indicate some deposition by turbidity currents.

The lithic components of the arenites are dominantly andesitic volcanics similar to the interbedded volcanics. The fragments comprise mostly green lavas and pyroclastics rich in green chlorite, and other purple volcanics heavily stained with iron oxide formed as an alteration product of original volcanic glass. In the arenites in the Langtry Gully Member, lithic grains of feldspar porphyry which contain large euhedra of pericline- and albite-twinned oligoclase are associated with similar detrital crystal-grains of oligoclase. Andesine is by far the most abundant feldspar grain-constituent throughout the formation; potash feldspar and albite are uncommon.

The arenites vary from strongly-sorted, cemented types, in which the fine matrix has been completely removed, to comparatively poorly-sorted tuffaceous types with fine matrix forming up to 20 per cent. of the rock. The matrices consist of a fine aggregate of feldspar, chlorite, calcite, epidote, leucoxene, opaque iron oxide, and altered volcanic glass. In several thin-sections, chlorite and analcite were seen to replace both matrix and lithic grains. Mineral cements are most commonly calcite and chlorite, but include also epidote, brown ferruginous-chlorite, and zeolite. The chlorite cements occur as radially-arranged fibrous aggregates, and clearly formed later than the calcite in many of the microslides examined.

Pyrite cubes, some up to 5 mm. square occur in some of the fine-grained arenites in the Milkman Creek and Denny Gully members.

The interbedded lavas in the Milkman Creek and Denny Gully Members are tough, greenish, and frequently vesicular andesites, similar to many of the andesites in the Kroombit Beds. Phenocrysts are mostly andesine, and occasionally clinopyroxene, in a pilotaxitic-textured groundmass; vesicles are infilled with calcite, chlorite epidote, quartz, chalcedony, and zeolite.

Thin-sections of the purple andesite in the Langtry Gully Member show water-clear phenocrysts of andesine in a groundmass almost opaque with iron oxides. Chlorite, absent from the groundmass, is well developed as radially-arranged fibrous aggregates in the numerous vesicles.

Fauna and Flora. Fossil marine faunas usually dominated by brachiopods, are distributed throughout much of the formation. Table 1 lists the identifications from each fossil locality and Table 3 shows the stratigraphic ranges of the more important species.

The brachiopods have been grouped into three faunal assemblages or "faunas": the *Cyrtiopsis* aff. *murchisonianus* Fauna, restricted to the Langtry Gully Member, the *Mesoplica* aff. *praelonga* Fauna, restricted to the Milkman Creek Member, and the *Cyrtospirifer sinensis* var. *australis* Fauna which occurs in only the South Kariboe and Denny Gully Members.

Cyrtiopsis aff. *murchisonianus* Fauna

Occurrences of this faunal assemblage are confined to the upper two-thirds of the Langtry Gully Member. The most richly fossiliferous localities are in the upper half of the member east of the Mulgildie Fault; only two comparatively poorly-fossiliferous localities (m/r 960375 and m/r 954380) were found in the outcrop-areas west of the Fault.

The assemblage is defined principally by the presence of *Cyrtiopsis* aff. *murchisonianus* (de Koninck), *C.* aff. *orbelianus* (Abich), and *Cyrtospirifer reidi* Maxwell. Other species present include *Giirichella* (?) sp. and *Productella* (?) sp., both of which are restricted to this assemblage, and *Schizophoria pierrensis* Veevers, *Cyrtospirifer subdisjuncta* Maxwell, *Mucrospirifer* cf. *kennedyensis* Maxwell, *"Giirichella"* sp. nov., *Camarotoechia* cf. *lucida* Veevers, and *Nayunnella* sp., which range into the *Mesoplica* aff. *praelonga* Fauna.

Large specimens of *Cyrtiopsis* and *Cyrtospirifer,* in well sorted, medium and coarse-grained calcareous lithic arenite, form a useful marker approximately 200 feet below the top of the Langtry Gully Member east of the Mulgildie Fault. *Cyrtospirifer reidi* occurs prolifically in several beds of fine-grained calcareous arenite, and is usually associated with scattered specimens of *Camarotoechia* cf. *lucida.*

Schizophoria pierrensis, Giirichella (?) sp., *"Giirichella"* sp. nov., *Mucrospirifer* cf. *kennedyensis,* and *Nayunnella* sp. are known from only one locality, L2227, where they occur in siltstone. *Cyrtiopsis* and both species of *Cyrtospirifer* are comparatively rare in siltstones, the one exception being at locality L2224, where abundant small shells of *Cyrtospirifer reidi* occur with numerous specimens of *Camarotoechia* in a bluish-grey siltstone.

Mesoplica aff. *praelonga* Fauna

This faunal assemblage is restricted to the Milkman Creek Member, and is characterized by the presence of the following species: *Schizophoria pierrensis, Schuchertella* sp., *Rhipidomella* (?) sp., *Mesoplica* aff. *praelonga* (Sowerby), *Sentosia* cf. sp. nov. a, *Cyrtospirifer subdisjuncta, "Giirichella"* sp. nov., *Athyris randsi* Etheridge, *Cleiothyridina* aff. *reticulata* Stainbrook, *Leiorhynchus* sp. nov., *Pugnoides* sp. nov., *Camarotoechia* cf. *lucida, Nayunnella* sp., *Crurithyris* sp. and *Retzia* (?) sp. Of these species only *Schizophoria pierrensis* and *Retzia* (?) sp. occur also in the *Cyrtospirifer sinensis* var. *australis* Fauna.

The brachiopods are found only in the bluish-green siltstones and are frequently associatad with numerous tiny crinoid stems. *Cyrtospirifer* is restricted to scattered specimens, in contrast to its abundance in the upper half of the Langtry Gully Member.

TABLE 1

DISTRIBUTION OF MARINE FOSSILS IN THE DAWES RANGE FORMATION

r – rare (1–2) c – common (3–10) a – abundant (11–) ?– doubtful specific determination

| | Langtry Gully Member | | |

To a certain extent, the differences in composition between the *Cyrtiopsis* aff. *murchisonianus* and *Mesoplica* aff. *praelonga* faunas may reflect facies differences rather than any marked age difference. This is indicated by the absence from the Milkman Creek Member of sandy facies faunas rich in *Cyrtospirifer* and by the similarity between the impoverished siltstone fauna at locality L2227 in the upper part of the Langtry Gully Member and the assemblages of the *Mesoplica* aff. *praelonga* Fauna.

Cyrtospirifer sinensis var. *australis* Fauna

This fauna which ranges through most of the South Kariboe and Denny Gully Members is marked by the incoming of the following species: *Retichonetes* sp. nov., *Sentosia* sp. nov. a, *Sentosia* sp. nov. b, *Avonia* aff. *niger* Gosselet, *Cyrtospirifer sinensis* var. *australis* Maxwell, *Tenticospirifer grandis* Maxwell, and *Athyris* sp. nov. Most of the assemblages are in fine and very fine-grained lithic arenite and are dominated by *Cyrtospirifer sinensis* var. *australis*. A few comparatively poorly fossiliferous localities are in green tuffaceous siltstones and yield scattered specimens of *Avonia* aff. *proteus, Crurithyris* (?) sp., *Retzia* (?) sp., and small gastropods.

Within the fauna, certain species are restricted to either the South Kariboe Member or the Denny Gully Member. *Sentosia* sp. a does not occur outside the South Kariboe Member, and *Sentosia* sp. nov. b, and *Tenticospirifer grandis* are found in only the Denny Gully Member.

Age. The brachiopods in the formation indicate a Famennian age, or more specifically, a lower or early upper Famennian age for the *Cyrtiopsis* aff. *murchisonianus* Fauna, and an upper Famennian age for the *Mesoplica* aff. *praelonga* and *Cyrtospirifer sinensis* var. *australis* Faunas.

In this paper, the base of the Carboniferous is taken at the bottom of the *Gattendorfia* Zone (Cu I), in the European goniatite zonal succession, and the Zone d'Etroeungt, long considered transitional between Devonian and Carboniferous, is regarded as uppermost late-Devonian.

Cyrtospirifer ranges throughout the Frasnian and Famennian but does not extend into the Tournaisian.

The genus *Cyrtiopsis* does occur in Frasnian overseas but is more typical of Famennian strata. *C. murchisonianus* is abundant in the lower and early-upper Famennian of France and Belgium.

The presence of *Mesoplica* is significant in age determination as this genus has not been recorded from pre-upper Famennian strata. Previous occurrences have been restricted to the upper Famennian in England (Pilton Beds) in France, Germany, Armenia, and Kazakhstan (Sulcifer Beds). This genus is readily distinguished by its costation and diagnostic median row of spines. *Avonia* also first appears in overseas faunas in the upper Famennian but ranges into the Lower Carboniferous.

Sentosia Muir Wood and Cooper, which is a short ranged productid genus with an ornament of fine hair-like spines, has previously been recorded from only the late Famennian Percha Shale of New Mexico. *Sentosia* sp. nov. b is particularly close to the type species *S. praecursor* Stainbrook.

Schizophoria pierrensis provides a correlation with Western Australian faunas as this species was described by Veevers (1959) from the Famennian of the Fitzroy Basin.

Tenticospirifer grandis most closely resembles *T. julii* Dehee from the Zone d'Etroeungt in France (Dehee 1929) and from the upper Famennian of Armenia (Abramyan 1957).

The earliest overseas occurrences of *Cleiothyridina* Buckman have been from upper Famennian strata in France, Armenia, and the United States. *C. reticulata* which has affinities with the species in the *Mesoplica* aff. *praelonga* fauna, was described by Stainbrook (1947) from the Percha Shale of New Mexico.

Nayunnella Sartenaer, erected to replace Grabau's genus *Yunnanella,* which was shown by Sartenaer (1961) to be invalid, is common in the Famennian of China, and does not range into the Lower Caboniferous.

Correlation. The Dawes Range Formation crops out east of the map area near Malakoff homestead where it is overlain by equivalents of the Three Moon Conglomerate. The formation has not been recognized elsewhere on the Monto 1:250,000 sheet but possibly equivalent basic volcanics and derived sediments underlie fossiliferous Tournaisian beds in the Calliope Range north-east of the Callide Opencut Coal Mine.

In the Mt. Morgan sequence described by Maxwell (1953), the Dawes Range Formation is correlated with the Thomson Clastics and the overlying Boulder Creek Grits. On overall lithologies, the two formations at Mt. Morgan are similar to the Dawes Range Formation. The Thomson Clastics, which overlie the Dee Volcanics, contain brachiopod assemblages rich in *Cyrtospirifer reidi* and *Cyrtiopsis* aff. *murchisonianus* and appear to be the equivalent of the Langtry Gully Member. Only two species *Sulcatospirifer primus* Maxwell and *Camarotoechia* cf. *contracta* Hall, were listed by Maxwell from the Boulder Creek Grits and are of little value in correlation with the faunas at Cania, although *Camarotoechia* cf. *contracta* has affinities with *C.* cf. *lucida* from the *Cyrtiopsis* aff. *murchisonianus* and *Mesoplica* aff. *praelonga* faunas.

Tenticospirifer grandis occurs at Mt. Morgan at an horizon that was placed by Maxwell in the basal part of the Pond Argillites which overlie the Boulder Creek Grits.

Several of the species from the Dawes Range Formation occur in the faunas of the Star Basin on the Townsville 1:250,000 sheet area which are being studied by R. G. McKellar of the Geological Survey of Queensland.

Environment of Deposition. The strong sorting of the arenites in the Langtry Gully and South Kariboe Members and the associated bedding structures reflect deposition by traction currents in a shallow-water marine environment. The comparatively poor sorting and poor stratification of the arenites in the other two

members may be attributed to more rapid sedimentation in a similar environment, resulting from active contemporaneous vulcanism; or alternatively, marine conditions may have been deep enough to prevent traction-current reworking.

Marine conditions were probably shallowest during the deposition of the lower half of the Langtry Gully Member as indicated by the prominent cross-lamination of arenites. Current-direction measurements indicate a prevailing north-easterly direction of sediment transport during the deposition of the Langtry Gully Member.

Stratigraphic Relationships. The Dawes Range Formation conformably overlies the Kroombit Beds, and the abrupt lithological change at the base of the Dawes Range Formation may reflect major changes in depositional environment rather than any significant stratigraphic break.

THREE MOON CONGLOMERATE

Definition. This new name, derived from Three Moon Creek, is applied to the early Lower Carboniferous sequence of volcanics, conglomerate, arenite, and siltstone, that underlies the Cania Formation in the Cania district. It is exposed in two north-west trending outcrop-areas east of the Kroombit Oaky and South Kariboe faults respectively, in small fault-blocks north-west of Cania, and in another extensive outcrop-area near Munholme Creek in the north-eastern corner of the map area.

Type Section. The type section (Text-fig. 2) extends along the ridges north of Kroombit-Oaky Creek between m/r 965412 and m/r 982387, then south into Three Moon Creek at m/r 982373, along the south-west of the creek to the junction with First Crossing Creek, and then up the ridge south-west of First Crossing Creek to the base of the Cania Formation at m/r 994358. The lower or northern end of the section is faulted against the Kroombit Beds. Local reversals of dip and numerous dolerite intrusions hinder accurate measurement of thickness; the estimated thickness in the section of approximately 2,300 feet has been calculated on an average easterly dip of 10 deg. in that part adjacent to Kroombit Oaky Creek, and an average dip of 15 deg. to the south-east in the upper part of the section from Three Moon Creek to the boundary of the Cania Formation.

The base of the formation is everywhere concealed by faulting in the map area. Probably the oldest rocks in the formation to crop out are easterly-dipping purple-weathering andestic lavas and volcanic conglomerates in Milkman Creek, between the Cania and Lee Yen faults.

The Conglomerate crops out well in the type area, in Twelve Mile and Middle Creeks near Blue Hills homestead, and in South Kariboe Creek north-east of the junction with Hawkins Gully.

Stratigraphic Succession. In the basal 200 feet (unnamed unit *a*) purplish-weathering lithic arenite and andesitic lavas are overlain by greyish-green pebble and granule conglomerate and interbedded lithic arenite. It is succeeded by 650 feet (unit *b*) of comparatively resistant yellowish-green cream and greyish-green granule and pebble conglomerate, lithic and feldspathic arenite, and interbedded siltstone, acid vitric tuff, and andesitic lava. Quartz is conspicuous in the hand specimen in many of the arenites and granule conglomerates in unit *b* and also in a few in unit *a*. Unit *c* comprises approximately 800 feet of pebble conglomerate, lithic arenite, siltstone, and andesitic lava. Unit *d* is poorly exposed and consists mostly of thinly-bedded purplish and greenish siltstone and mudstone. Most of the remaining 500 feet (unit *e*) comprises andesitic lava, boulder to pebble volcanic conglomerate, and minor lithic arenite. Thick conglomeratic beds in the upper half of the unit are useful marker beds, particularly as they tend to crop out prominently in relation to the surrounding rocks.

Unit *e* crops out extensively on the south-western side of the Mulgildie Fault from south of Comet Gully north-west into South Kariboe Creek. The outcrops in South Kariboe Creek between the Mulgildie and South Kariboe faults and in Middle Creek between the South Kariboe and Blue Hills faults, are mostly of units *c, d,* and *e*.

The base of the overlying Cania Formation is marked by an abrupt change in lithology from purplish and dark-green andesite to resistant, bluish-grey acid vitric-tuff, and cherty siltstone.

Lithology. The rocks of the Three Moon Conglomerate are characterized by a high percentage of lithologies that are purple-weathering, and by the widespread development of zeolites in the cements and matrices of the arenites and granule conglomerates. The relative prominence of quartz in some of the arenities in units *a* and *b,* is in contrast to the virtual absence of this mineral from the older rocks in the Kroombit Beds and Dawes Range Formation.

Conglomerates are essentially of three types, the least abundant of which are yellowish-green and greyish-green and composed of subangular fragments of acid volcanics and andesite in a silicified, often tuffaceous matrix. These conglomerates are non-zeolitic and rarely purple weathering.

Volcanic conglomerates are most typical of unit *e* and consist of rounded and subrounded boulders, cobbles, and pebbles of andesitic volcanics in a tuffaceous andesitic matrix which is frequently zeolitic. Some have zeolitic mineral cements. When fresh, many of the conglomerates have the appearance of homogeneous lavas, and the conglomeratic texture becomes apparent only on a weathered surface.

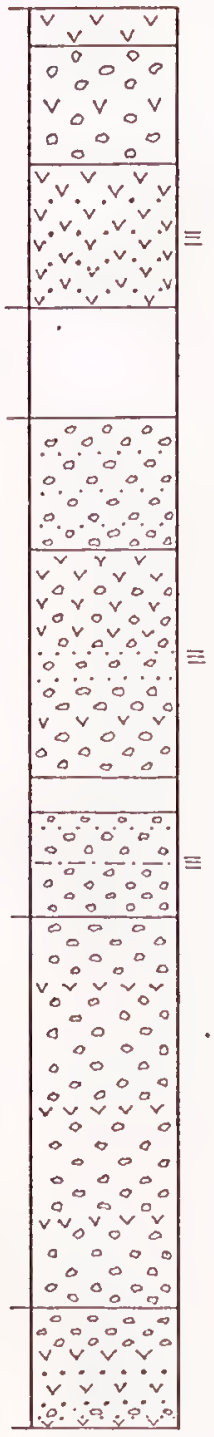
In the third type of conglomerate which is well developed in units *a* and *c,* fragments are mostly of greyish-green, thinly-bedded siltstone, and lesser andesitic volcanics. The larger siltstone clasts are rounded and discoidal and up to 1 foot in diameter; the smaller clasts are usually angular or subangular. The conglomerates are well sorted and often have a white zeolite cement. Although the siltstone clasts are identical with interbedded siltstones in the formation and appear to have been derived from penecontempor-

FIG. 2

THREE MOON CONGLOMERATE

Generalised Stratigraphic Section based on type section

Scale 1" = 400'



	Green & purple andesitic lava.
Unit e	Boulder, cobble, pebble, & granule volcanic conglomerate & andesitic lava.
≡	Green & purple andesitic lava & lapilli tuff; interbedded zeolitic medium & fine grained lithic arenite.
Unit d	Poorly exposed; some purple & green siltstone & mudstone.
	Green & purple zeolitic granule conglomerate; interbedded zeolitic medium & coarse grained lithic arenite & grey green pebble conglomerate.
Unit c ≡	Green & purple zeolitic granule conglomerate, and coarse medium and fine grained lithic arenite; interbedded andesitic lava.
≡	Green & purple zeolitic pebble and granule conglomerate and medium & coarse grained lithic arenite; interbedded siltstone.
Unit b	Resistant yellow green and grey green pebble and granule conglomerate & lithic & feldspathic arenite; some siltstone, acid vitric tuff & andesitic lava.
Unit a	Grey green and purple pebble and granule conglomerate, medium & coarse lithic arenite and green and purple andesitic lava.

≡ laminated

aneous erosion, the conglomerates differ from typical intraformational breccia conglomerates in their well sorted matrix and the rounding of the larger fragments.

In most of the arenites, feldspar is subordinate to lithic grains, and the rocks are classified as lithic labile arenites. Only in unit *b,* are feldspathic labile arenites abundant. Strong sorting, prominent stratification including occasional cross-stratification, and the absence of graded-bedding, indicate the "sandstone" suite of Crook (1960).

The arenites are principally of two types, one containing abundant acid volcanic detritus with little development of zeolite, and the other composed of andesitic and siltstone fragments and having well developed zeolitic matrices and cements.

Many of the lithic and feldspathic arenites in units *a* and *b* are comparatively resistant, yellowish-green or cream coloured rocks in which quartz is conspicuous in the hand specimen. In thin section, they are seen to consist of lithic grains of silicified acid volcanics, andesitic volcanics, siltstone, and feldspar and quartz. The feldspar includes andesine, oligoclase, and potash feldspar; quartz, which forms up to 20 per cent. of the rock, is present as embayed grains of volcanic origin. Mineral cements are uncommon and usually siliceous. Alunite replaces tuffaceous matrix in some microslides.

Purplish, greyish-green, and dark green lithic arenites that are quartz-poor and comparatively soft-weathering are dominant throughout much of the formation. They consist mostly of lithic grains of andesitic volcanics and siltstone, and plagioclase; they are well sorted and fine matrix usually does not exceed 15 per cent. Zeolites are abundant both as a replacement of tuffaceous matrix and as mineral cements, when they are usually associated with one or more other mineral cements including calcite, chlorite, prehnite, peidote, clinozoisite, and quartz. Quartz, epidote, and zeolites are associated as a fine granular mosaic partly replacing lithic grains and matrix in some microslides; quartz forms overgrowths on scattered quartz grains in several of these slides. In the vicinity of doleritic sills and dykes, cements and matrices in both arenites and conglomerates have been hornfelsed into a tough silicified and epidotized aggregate. Consequently, the effects of diagenesis and local thermal metamorphism become difficult to distinguish between in certain thin-sections.

The andesitic volcanics mostly comprise lavas that are dark-grey or black to greenish-black when fresh but are frequently purple-weathering. Colour differences and their softer weathering habit separate them from the tough andesitic lavas of the Dawes Range Formation. In thin section, the lavas are made up of seriate phenocrysts of andesine and/or oligoclase set in a pilotaxtic or trachytic textured groundmass of plagioclase, chlorite, pyroxene, calcite, and opaque iron oxide. Vesicles are infilled with zeolite, calcite, and chlorite.

Fauna and Flora. Indeterminate plant stems are scattered through the formation.

Marine fossils were found at only one locality (L2250), in a lithic arenite in unit *e,* 1·5 miles north-north-east of Cania.

The fauna includes *Schizophoria* aff. *resupinata* (Martin), *Leptagonia* sp., *Streptorhynchus* (?) sp., *Tylothyris* sp., *"Giirichella"* aff. *kennedyense* (Maxwell), *Athyris* spp., *Axiodeaneia* sp., *Perissothyris* cf. *masonensis* Carter, *Retzia* sp., *Polidevcia* cf. *tulcumbensis* Campbell and Engel, *Myalina* sp., *Eoschizodus* sp., *Cypricardinia* sp., *Panenka* cf. *porteri* Benson and Dun, *Bellerophon* sp., *Baylea* sp., *Naticopsis* sp. and *Loxonema* sp.

Age and Correlation. The stratigraphic position between the Famennian Dawes Range Formation and the upper Tournaisian Cania Formation indicates a lower Tournaisian age for the formation.

The contained fauna has little in common with the lower Tournaisian brachiopod faunas of the Pond Argillite of the Mt. Morgan district, mostly because of facies differences. However, near Glengowan station approximately 25 miles south-south-east of Mt. Morgan, arenites containing *Perissothyris* cf. *masonensis* are interbedded with blue cherty siltstones containing diagnostic Pond Argillite assemblages including *Prospira morganensis* (Maxwell) *Avonia kennedyensis* Maxwell, and *Rugosochonetes kennedyensis* Maxwell, thus providing a faunal basis for correlation of the Three Moon Conglomerate with the Pond Argillite. The two occurrences in the Yarrol Basin of *Perissothyris* Carter, a spiriferacean with an unusual growth habit and unique internal apical structure (Hill and Woods 1964, pl. 9, figs. 6–9), are the only ones known outside the type locality in the late Mississippian Barnett Formation in Texas.

"Giirichella" aff. *kennedyense, Panenka* cf. *porteri,* and *Polidevcia* cf. *tulcumbensis* compare closely with species described by Campbell and Engel (1963) from the lower or early upper Tournaisian Tulcumba Sandstone in New South Wales. *Spirifer lirellus sol* Campbell and Engel, described from the Tulcumba Sandstone, is abundant in the lower part of the Cania Formation, suggesting the fauna in the Three Moon Conglomerate may be slightly older. The Sandstone overlies disconformably, or with low angle unconformity, the upper Devonian Baldwin Formation; it contains interbedded oolitic limestone.

The fauna at locality L2250 differs completely from the faunas of the Dawes Range Formation, and marks the earliest appearance in the succession of *Leptagonia* which is abundant in the Lower Carboniferous faunas of eastern Australia. *Schizophoria* aff. *resupinata* has closest affinity with Lower Carboniferous species.

Stratigraphic Relationships. The boundary between the Three Moon Conglomerate and Dawes Range Formation is everywhere concealed by faulting in the map area. The formation crops out extensively east of the map area near Malakoff station and overlies probable equivalents of the Dawes Range Formation. The boundary is marked by a change from resistant green volcanics and volcanic sediments to less resistant, purple-weathering andesitic volcanics and volcanic

conglomerate. A volcanic conglomerate composed of angular and subangular fragments of greenish-black lava in a calcite cement is developed at the base of the Three Moon Conglomerate in Dooloo Creek along the track from Monal Creek to Dooloo Tops station.

No stratigraphic break could be detected between the Three Moon Conglomerate and Dawes Range Formation but it is conceivable that uplift in the western part of the basin in the lower Tournaisian, indicated by the coarse conglomerates in the formation, may have resulted in local overlap of the older Devonian rocks in some parts of the basin.

Environment of Deposition. The sediments of the Three Moon Conglomerate are thought to have been deposited in a shallow marine environment in which traction currents were active.

CANIA FORMATION

Definition. In a discussion on the Lower Carboniferous coral faunas of Queensland, Hill (1943) used the term "Cania limestone" informally in referring, in a correlation chart, to the oolitic limestone in Three Moon Creek, near Cania township. The new name Cania Formation is now proposed for the major sedimentary unit containing this oolitic limestone and is defined as the Lower Carboniferous sequence of arenite, conglomerate siltstone, oolitic and crinoidal limestone, and interbedded acid and basic volcanics, that conformably overlies the Three Moon Conglomerate and is disconformably overlain by the Lower Permian Youlambie Conglomerate in the map area.

The formation takes it name from Cania township.

Type Section. The proposed type section lies south of the Cania-Karrawong homestead road, between m/r 915396 and m/r 925378. Because of overlap of the Cania Formation by the Youlambie Conglomerate, the youngest parts of the formation are not exposed in this section, and a supplementary section through the upper part of the formation is designated almost four miles to the east, south of Three Moon Creek between m/r 990384 and m/r 997381. The total thickness of the formation in the two sections is 1,750 feet.

The formation is well exposed in German Gully, Milkman Creek, Four Mile Creek, Three Moon Creek near Cania, Casuarina Gully, and in South Kariboe Creek west of the Mulgildie Fault.

Stratigraphic Succession. To facilitate discussion of the sequence, the Cania Formation is divided into four unnamed units (Text-fig. 3).

Unit *a* comprises the basal 450 feet of the formation and consists of silicified acid vitric and crystal tuffs, thin-bedded cherty tuffaceous siltstone and mudstone, and interbedded feldspathic arenite and granule conglomerate. The unit is distinctive lithologically because of the overall fine grain size, strong silicification, and abundance of graded-bedded tuffaceous siltstone and mudstone. South of First Crossing Creek, thin lenses of crinoidal limestone less than one foot thick are interbedded in mudstone at the base of the unit. Further south, on the ridges east of Boolgal Creek lenses of crinoidal limestone up to several feet thick occur higher in the unit. These crinoidal limestones are absent in the type area. Rich marine fossil bands are found in bluish-grey siltstone towards the top of the unit and are associated with thin lenses of oolitic limestone in the type section and also at m/r 945370, m/r 007348 and m/r 009347.

The coarser-grained unit *b,* 575 feet thick in the type section, is composed of pebble and granule conglomerate, lithic and feldspathic arenite, interbedded andesitic lithic and lapilli tuff, and minor dacitic vitric and crystal tuff. Many of the lithologies are purplish weathering and calcareous. Several lenses of oolitic limestone up to 20 feet thick occur in the unit northwest of Mahoon homestead. None were found in the unit nearer Cania.

Unit *c* is approximately 500 feet thick in the type section. It commences with 125 feet of brownish-green siltstone, mudstone, and minor fine-grained calcareous lithic arenite, overlain by several feet of cobble conglomerate composed of rounded andesitic volcanic fragments. Then follows oolitic limestone lens *"a"* which is up to 40 feet thick, and forms a useful marker bed in the western part of the map area near Cania. This limestone lenses out in a southerly direction and disappears south of Well Creek and on the southwestern side of the Four Mile Fault. Limestone lens *"a"* is the "Cania limestone" referred to by Hill (1943). Locally, the limestone contains small pockets crowded with shells of the brachiopod *Martinia productoides* Eth.

Near Cania, the limestone is overlain by up to 200 feet of calcareous lithic arenite, pebble to granule conglomerate, siltstone, and andesitic lava, and lithic and lapilli tuff; these rocks which are directly overlain by the Youlambie Conglomerate are the youngest Lower Carboniferous rocks exposed in the western part of the map area.

Near Three Moon Creek, 2·5 miles north-east of Cania, limestone lens *"a"* is overlain by over 300 feet of calcareous lithic arenite, pebble to granule conglomerate, siltstone, and andesitic volcanics of unit *c.* Overlying these rocks are 250 feet of silicified rhyolite lava and vitric and crystal tuff, pebble and granule conglomerate, feldspathic and lithic arenite, tuffaceous siltstone, and oolitic limestone, that constitute unit *d.* Oolitic limestone lens *"b"* is up to 60 feet thick in the outcrop area east of the Blue Hills Fault and is well exposed along the road from Cania to Mahoon station. It also contains fossiliferous pockets of *Martinia productoides* and is underlain by rhyolitic crystal tuff.

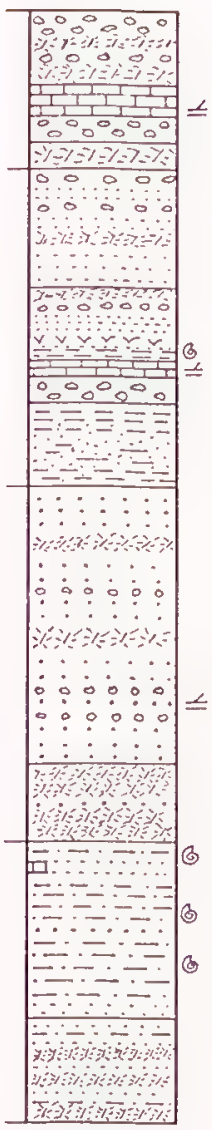
Unit *d* is overlain by the Youlambie Conglomerate in the upper part of First Crossing Creek. For several miles between First Crossing Creek and Middle Creek the boundary between unit *d* and the lower part of the Youlambie Conglomerate is obscured by numerous intrusions, probably sills, of feldspar porphyry and dolerite.

FIG. 3

CANIA FORMATION

Generalised Stratigraphic Section based on type section

Scale 1" = 400'



Unit d

Unit c

Unit b

Unit a

L. 2256

D. 73

L. 2254

Cream and blue-grey silicified vitric and crystal rhyolitic tuff and fluidal lava, granule conglomerate, and feldspathic and lithic arenite.
Oölitic limestone - lens "b"

Pebble conglomerate, composed of acid and basic volcanics.
Cream and blue-grey silicified vitric and crystal rhyolitic tuff.

Green and purple calcareous granule conglomerate, and medium and coarse lithic arenite; interbedded andesitic lapilli and lithic tuff, and pebble conglomerate composed of andesitic detritus.

Blue and brown calcareous fine-grained feldspathic arenite and siltstone; interbedded granule conglomerate and lithic and feldspathic arenite; fossiliferous mudstone at base.
Oolitic limestone - lens "a"
Cobble, pebble, and granule conglomerate, composed of andesitic volcanics.

Blue and brown tuffaceous siltstone, mudstone, and fine feldspathic arenite.

Pebble and granule conglomerate and medium and coarse-grained lithic arenite, andesitic crystal and lithic lapilli tuff, tuffaceous siltstone; conglomerate predominantly of andesitic volcanics.

Grey-green vitric and crystal dacitic tuff, and interbedded green and purple granule conglomerate and medium and coarse-grained lithic and feldspathic arenite.

Silicified blue-grey tuffaceous siltstone & mudstone; fine-grained feldspathic arenite, interbedded blue-grey medium and coarse feldspathic arenite and minor granule conglomerate; thin lenses of oolitic limestone at top.

Silicified blue-grey vitric and crystal dacitic tuff, siltstone, medium and fine-grained feldspathic arenite.

Marine fossil locality
Cross bedded
Laminated

TABLE 2

DISTRIBUTION OF MARINE FOSSILS IN THE CANIA FORMATION

r—rare (1–2) c—common (3–10) a—abundant (11— .) ?—doubtful specific determination

GRID REFERENCE	927466	945369	942442	012472	917386	916387	886402	888404	896386	899386	905385	908386	932405	936417	946404	948403	963384	964383	999364	994359	997357	000357	938366	942370	943365	941347	007338	005350	917387	924379	943362	942357	948360	949362	949367	967349	004364	005359	994378	990385	978396	981399	983398	987391	994383	958426	994383	999466	006470	016439
LOCALITY NUMBER				D 175	L2254											L2258		L 1995			L2255			L2257	L2008		L2009	L1996	D 73	L2256	L2005	L2006				L2007		L2253			L1998	L2002	L2001	L1999		D.74 L2004			D 180
Schellwienella sp. nov.			c	c	a		c			c	c	c	a				a	r					a	a		a	c		r	c	r														c			
Schuchertella sp.					r																				c				r								r												
Rugosochonetes kennedyensis var. magnus Maxwell	a	a	c	a	a		a		a	a	a	a	a		a		a				a	c	a	a	a	a	a	a	a	c	c					c												
Pustula sp. nov.		c			a						a		a		c		a				a		c	a			a		a		r								?	?								
Linoproductus sp.					r																																												
Prospira prima Maxwell	a	a	c	c	a			c	a		a	a	a		a		a				a	c	a	a		a	a	r	a	r	r	r				r				r	r							
Spirifer lirellus sol Campbell & Engel		c			a		c		c			a	a				c				c	r	c	a	a	a	c		a							r												
Syringothyris sp.					r																								r																				
Cleiothyridina biconvexa Maxwell		c		c	c								c				c				c			c		c	c		c																			
Brachythyris sp.		c			c												c				c		c	c			c		c																			
Camarotoechia sp.					a								c				c						c	c					c	c	c			c	c	c		c				c						
Sanguinolites sp.					r	a								a		a			a	a									r																				
Modiomorpha ? sp.					r	a								a		a			a	a																													
Edmondia sp.					r																r								r		r			c			c		r	c	r							
Palaeoneilo sp.					r					a		c												c	a		c		r	r	c					c			r		c								
Yunnania sp.					c																a								r					r			c		c								
Waagenella stanvellense (Etheridge)																										c			c	r																		
Loxonema sp.					c												r							c	a		c		r																		
Phymatifer sp.					r																r								r	c	c																
Straparollus sp.					c												c				r			c	c		c		c	c	c					c		a									
Crinoid calices		c			c												c				r		c						r	c	c	c				c											
Schizophoria verulamensis Cvancara																														c	c																	
Rhipidomella australis (McCoy)																														c	c			c		a		a			a	a	a					c	
Leptagonia cf. analoga (Phillips)																														a	a	c		c		a		a			c	a	a						
Plicochonetes sp.																															c			r		c		c			c	c	c						
Antiquatonia sp. nov.																														a	a	a		c	c	a		a				a				a			
Prospira typa var. tellebangensis Maxwell																														a	a	a				a		a		c	a	a	a	c	c	c	c			
Prospira aff. striatoconvoluta (Benson & Dun)																																																a			
Martinia productoides Etheridge																																	a			c		a	a	a	a			a		a		a		a	
Brachythyris aff. solida Campbell & Engel																														c	a	a		c		a	a	a			a	a	a				a			
"Tylothyris" sp.																																															c			
Cleiothyridina transversa Maxwell																														c	a					c		c				a	c						
Cleiothyridina australis Maxwell																															c					c							c						
Phricodothyris cf. uniplicata Campbell																															r											r				c	c			
Retzia ? sp.																																				r											c			
Palaeacis cf. cuneiformis Haime																																	r																
Amygdalophyllum sp.																																				r					r								
Waagenella microstriata Maxwell																																				c						c							
Phillipsia sp.																																				r		r				r	r						

Spirifer lirellus sol fauna

Prospira typa var. tellebangensis fauna

The north-eastern part of the map area, on the north-eastern side of the Three Moon Fault, has not been mapped in detail and the four units have not been recognized. An oolitic limestone cropping out on the Cania-Mahoon road, ½ mile south-west of Mahoon station contains pockets of *Martinia productoides* and is underlain by rhyolitic crystal tuff; it is correlated with limestone lens *"b"* further south-west. This limestone also crops out at m/r 998465 almost 2 miles to the north-north-west. No more than 200 feet of strata lie between this limestone and the boundary with the Youlambie Conglomerate. This boundary appears faulted south-east of Three Moon Creek but may be stratigraphic further to the north-north-west.

A thick lens of oolitic limestone approximately 500 feet below the limestone at m/r 998465 may be the equivalent of limestone lens *"a"*; it is probably the same limestone that crops out 150 yards south-east of Mahoon station.

Lower in the sequence, oolitic limestone containing assemblages typical of the *Spirifer lirellus sol* Fauna crops out east of Three Moon Creek at m/r 013472.

East of the map area, near Malakoff station, an oolitic limestone lens up to 30 feet thick occurs near the base of the Cania Formation in equivalents of unit *a,* and contains a fossil assemblage from the *Spirifer lirellus sol* Fauna. Another oolitic limestone containing *Martinia productoides* occurs much higher in the sequence.

In the type area of the Youlambie Conglomerate near Youlambie Creek halfway between Cania and Monto, the Lower Permian formation overlies an oolitic limestone associated with rhyolite tuff. This limestone is the probable equivalent of limestone lens *"b"*.

Lithology. The most distinctive rocks of the Cania Formation are the oolitic limestones which first appear towards the top of unit *a* as thin impersistent lenses, and form two useful marker beds in units *c* and *d* respectively. Parts of the limestones are prominently cross-stratified with low inclined cross-laminae. In thin sections the limestones are seen to be well sorted and to consist of oolites up to 2 mm. in diameter cemented by a granular mosaic of calcite. Fibrous green chlorite is also present as a minor mineral cement in some thin sections. The oolites consist of a nucleus, usually a lithic grain or fragment of feldspar, quartz, or organic calcite, covered by concentric layers of finely crystalline calcite. Along strike, the oolitic limestones grade into calcareous lithic arenites and granule conglomerates which contain oolites.

The conglomerates of unit *a* consist mostly of acid volcanic fragments; those of units *b* and *d* of a mixture of acid and andesitic volcanics with the latter dominant; and those of unit *c* almost completely of andesitic volcanics, Plutonic rock fragments are virtually absent throughout. Most of the conglomerates are well sorted, and some have a calcite mineral cement.

The arenites include both lithic labile and feldspathic labile types, the former usually associated with a high andesitic detrital content and the latter with a high acid-volcanic content. They are mostly well sorted and well stratified. Some are cross-stratified with low inclined cross-laminae. The poorer sorted arenites are mostly tuffaceous. The arenites are within the "sandstone suite" of Crook (1960).

The principal grain constituents of the arenites are andesitic, dacitic, and rhyolitic lithic fragments, and plagioclase, potash feldspar, and quartz. Andesitic grains are green and rich in chlorite, or purple and stained with iron oxides, and where dominant as in units *b* and *c,* impart these respective colours to the hand specimen. By contrast, the acid-volcanic arenites of units *a* and *d* are bluish-grey in the hand specimen. Quartz is most abundant in unit *d* where it occurs as large embayed grains of volcanic origin, and forms approximately 25 per cent. of the rock, ranging up to 50 per cent. in a few specimens. Quartz is also conspicuous in the arenites in unit *a* and forms from 10 per cent. to 15 per cent. of the rock. The percentage is generally considerably less in units *b* and *c.* Potash feldspar is abundant in unit *d* and occurs as grains up to 2mm in length. Green or brown biotite flakes are a prominent accessory in units *a* and *d.*

The arenites are usually well sorted, and matrix is less than 15 per cent.; mineral cements are common. Matrices in units *b, c* and *d* are chloritic and calcareous. Silicia and brown ferruginous chlorite are the principal mineral cements in unit *a,* epidote and clinozoisite in unit *b,* calcite, green chlorite and analcite in unit *c,* and silica, brown and green chlorite and calcite in unit *d.* Chlorite is formed later than the calcite.

Some of the graded-bedded, white weathering cherts, abundant in unit *a,* are seen in thin-section to be silicified vitric acid tuffs. They grade into silicified tuffaceous siltstone and mudstone.

The brownish-green siltstones and mudstones in unit *c* are comparatively soft, and poorly bedded. Some are of tuffaceous origin but related to andesitic rather than to acid vulcanicity.

Among the acidic pyroclastics, vitric and crystal tuffs predominate, whereas among the andesitic pyroclastics, lithic and lapilli tuffs are dominant. Interbedded andesitic lavas are uncommon in the Cania Formation; they are dark-grey to black when fresh, and mostly non-porphyritic and vesicular.

Fauna and Flora. Marine fossils, mostly brachiopodal and molluscan, occur throughout most of the Cania Formation, but tend to be concentrated adjacent to the oolitic limestones. Faunal identifications are set out in the species distribution chart, Table 2, and the stratigraphic range of the more important brachiopod species are shown in Table 3.

Two faunal assemblages, based principally on the distribution of the brachiopods, are recognised, namely the *Spirifer lirellus sol* Fauna and the *Prospira typa* var. *tellebangensis* Fauna.

Spirifer lirellus sol Fauna

Assemblages from this Fauna are defined by the association *Schellwienella* sp. nov., *Rugosochonetes kennedyensis* var. *magnus* Maxwell, *Pustula* sp. nov. *Spirifer lirellus sol, Prospira prima* Maxwell, *Brachythyris* sp., and *Cleiothyridina biconvexa* Maxwell, and also by the absence of certain species diagnostic of the *Prospira typa* var. *tellebangensis* Fauna including *Rhipidomella australis* (McCoy), *Leptagonia* cf. *analoga* (Phillips), *Antiquatonia* sp. nov., and *Prospira typa* var. *tellebangensis* Maxwell. The species of *Schellwienella, Rugosochonetes,* and *Prospira* range into the younger *P. typa* var. *tellebangensis* Fauna, but by comparison with their abundance in *Spirifer lirellus sol* assemblages are poorly represented. Other species in the Fauna include *Schizophoria verulamensis* Cvancara, *Camarotoechia* sp., *Yunnania* sp., and *Waagenella stanvellense* (Etheridge) which are found also in the *Prospira typa* var. *tellebangensis* Fauna.

This Fauna is restricted to units *a* and *b* of the Cania Formation, and has its most prolific development towards the top of unit *a.* By far the most accessible fossil locality is in the type area south of the Cania-"Karrawong" road (localities L2254 and D72). The assemblages are mostly in silicified bluish-grey siltstone. Interbedded with silicified siltstones containing the brachiopod dominated assemblages, are soft often black siltstones crowded with thin shelled pelecypods referred to *Sanguinolites* and *Modiomorpha.*

Prospira typa var. *tellebangensis* Fauna

This faunal assemblage is marked by the incoming of two widely distributed and long ranging species *Rhipidomella australis* (McCoy) and *Leptagonia* cf. *analoga* (Phillips), and other diagnostic species *Antiquatonia* sp. nov., *Prospira typa* var. *tellebangensis* Maxwell, *Martinia productoides* Etheridge, and *Brachythyris* aff. *solida* Campbell and Engel. Other species present include *Schizophoria verulamensis, Rugosochonetes kennedyensis* var. *magnus, Plicochonetes* sp., *Prospira prima, Cleiothyridina transversa* Maxwell, *Cleiothyridina australis* Maxwell, *Phricodothyris* cf. *uniplicata* Campbell and *Camarotoechia* sp.

The Fauna is found in units *c* and *d.* Apart from occurrences of *Martinia productoides* in limestone lens *"b",* only one fossil locality (L2004) was found in unit *d,* in siltstone underlying limestone lens *"b".* The contained fauna differs slightly from those in unit *c* in containing *Prospira* aff. *striatoconvoluta* (Benson and Dun) and *Tylothyris* sp., in addition to most of the species typical of the *Prospira typa* var. *tellebangensis* Fauna.

Most of the assemblages are found in siltstone and mudstone in unit *c.* The major exception is the occurrences of *Martinia productoides* which is found in isolated richly fossiliferous pockets in oolitic limestone.

Age. The faunas indicate an upper Tournaisian age for the formation. There are strong affinities with the fauna of the upper Tournaisian Chouteau Limestone of the Mississippi Valley and with Tournaisian faunas in England and Belgium, and in the Moscow Basin. The faunas have close affinity with upper Tournaisian assemblages from Old Cannindah (Maxwell, 1961) and Mt. Morgan (Maxwell, 1954), both of which are also in the Yarrol Basin.

Schellwienella sp. nov. (figured in Hill and Woods, 1964, pl. 5 figs. 5–7) compares closely with *S. aspis* mut. *radialiformis* Demanet from the Tournaisian Tn 2 and Tn 3 substages of Demanet (1958) in Belgium, *S. crenistria* mut. z Vaughan from the K and Z Zones of south-western England, and to *S. burlingtonensis* Weller from the early Viséan Burlington Limestone of the Mississippi Valley and from the upper Tournaisian of the Moscow Basin (Sarycheva and Sokolskaya, 1952).

Spirifer lirellus sol has close affinities with *S. striatiformis* Meek (as figured by Weller 1914) and *S. gregeri* Weller from the Chouteau Limestone, and with *S. cinctus* Keyserling (as figured by de Koninck 1887) and *S. subcinctus* de Koninck from the Tn 2 and Tn 3 substages of Belgium.

Pustula sp. nov. resembles *P. echinata* Moore and *P. chouteauensis* Branson from the Chouteau Limestone, and *P. subpustulosa* Thomas from the K and Z Zones of south-western England.

Prospira prima bears close resemblance to *Spirifer piersonensis* Moore from the Chouteau Limestone, *Prospira* typa var. *tellebangensis* has affinities with *Spirifer louisianensis* Weller and *S. platynotus* Weller from the upper Tournaisian of the Mississippi Valley, with *S. clathratus* McCoy from the Tournaisian of Great Britain, *S. attenuatus* Sowerby (as figured by Delepine 1928) from the late Tournaisian and early Viséan of Belgium, and *S. tornacensis* de Koninck, *S. taidonensis* Tolmachoff, and *S. pentagonus* de Koninck, figured by Sarycheva and Sokolskaya 1952, from the upper Tournaisian of the Moscow Basin.

Of overseas species, *Antiquatonia* sp. nov. (figured in Hill and Woods 1964, pl. 7, figs. 15–17) appears closest to *Productus sedaliensis* Weller from the Chouteau Limestone and *Productus vaughani* Muir Wood from the Z Zone in south-western England.

Rhipidomella australis, Schizophoria verulamensis, and *Leptagonia* cf. *analoga* are comparatively long ranging species that have affinities with both Tournaisian and Viséan forms overseas and are common in both upper Tournaisian and Viséan faunas in eastern Australia.

Correlation. A close correlation can be made between the *Prospira typa* var. *tellebangensis* Fauna and that described by Maxwell (1961) from the upper part of the "Tellebang Formation" at Old Cannindah, south-east of Monto. The fauna at Old Cannindah, considered by Maxwell to be Upper Tournaisian, includes *Rhipidomella australis, Rugosochonetes kennedyensis* var. *magnus, Prospira burnettensis* Maxwell which is difficult to separate from *P. prima, P. typa* var. *tellebangensis, Martinia neoproductoides* which is morphologically close to *M. productoides,* and *Phricodothyris uniplicata.* This fauna occurs over 2,000 feet below the thick reef limestone at Old Cannindah,

which suggests that the upper part of the Cania Formation in the map area is older than the reef limestone which is Viséan in age.

The Carboniferous sequence in the eastern part of the Yarrol Basin in the Yarrol–Dakiel area differs considerably from that in the Cania area which lay much closer to the western margin of the basin. The youngest Lower Carboniferous rocks in the map area are Upper Tournaisian and are disconformably overlain by Lower Permian beds whereas, in the east, a thick sequence of lower, middle, and probably upper Viséan strata are disconformably overlain by the marine Upper Carboniferous Branch Creek Formation (Dear unpub. Ph.D. thesis 1963, McKellar 1965).

McKellar (1967) has divided the Lower Carboniferous sequence in the New Cannindah–Dakiel area, approximately 20 miles east-south-east of Cania, into five formations, in ascending order—Crana Beds, Bancroft Formation, Splinter Creek Formation, Dakiel Formation, and Baywulla Formation. The latter four formations have been grouped by McKellar as the Caswell Creek Group. The Crana Beds are equivalent to units *a* and *b* of the Cania Formation and at least part of the Three Moon Conglomerate. At the base of the Bancroft Formation is the Herring Gully Limestone Member which contains *Martinia productoides* and is correlated with either limestone lens *"a"* or lens *"b"* at Cania. *Rhipidomella australis, Leptagonia* cf. *analoga, Schellwienella* sp. nov., and *Prospira typa* var. *tellebangensis* occur in the basal part of the Bancroft Formation and suggest correlation with the *Prospira typa* var. *tellebangensis* Fauna. The Bancroft Formation which is 3,000 feet thick consists mostly of mudstone but includes some thick interbedded medium and coarse-grained arenite approximately 600 feet above the base. The upper part of the Bancroft Formation, and the overlying formations are younger than the Cania Formation. The Herring Gully Limestone Member is the oldest oolitic limestone in the New Cannindah–Dakiel area, but older oolitic limestones occur below this level (in equivalents of the upper part of the Crana Beds) in the map area and also near Malakoff station.

The oldest Lower Carboniferous fauna from the Yarrol district, the small assemblage described by Maxwell (1960) from the top of the Tellebang Formation, is younger than the faunas of the Cania Formation, and is of probable Viséan age.

A strong correlation can be made between the *Prospira typa* var. *tellebangensis* Fauna and the faunas of the upper Tournaisian *Schizophoria* Zone of Maxwell (1954) at Mt. Morgan which contains *Rhipidomella australis, Schizophoria verulamensis, Leptagonia* cf. *analoga, Prospira typa* Maxwell, *P. prima,* and *Cleiothyridina australis.* A prominent oolitic limestone towards the top of the lower one third of the Neils Creek Clastics, which is the interval containing the *Schizophoria* Zone, is an approximate equivalent of oolitic limestone lens *"a" or "b".* Underlying the Neils Creek Clastics are the Pond Argillites, that contain the Tournaisian faunas of the *Chonetes* Zone of Maxwell correlated with the fauna in the upper part of the Three Moon Conglomerate.

In the Neerkol district, the Lower Carboniferous sequence has been divided into the Gudman Oolite, Malchi Formation, and Lion Creek Limestone by Fleming (1967). The three formations together constitute the Rockhampton Group which has its type area in the Neerkol district and has been redefined by Fleming. *Rhidomella australis, Schizophoria verulamensis, Leptagonia* cf. *analoga, Prospira typa,* and *P. Prima,* occur in the basal part of the Malchi Formation and suggest correlation with the *Prospira typa* var. *tellebangensis* Fauna. Units *a* and *b* of the Cania Formation which contain the *Spirifer lirellus sol* Fauna appear to be older than the base of the redefined Rockhampton Group.

In the Gresford–Dungog district in New South Wales, Roberts (1965) recognized three faunal zones and one faunal assemblage within the Lower Carboniferous sequence. The earliest zone, the *?Thomasaria voiseyi* Zone, contains *Productina globosa* (which occurs in the *Schizophoria* Zone at Mt. Morgan and in the lower part of the Malchi Formation at Stanwell) in addition to *Schizophoria verulamensis, Rhipidomella australis* and *Leptagonia* cf. *unaloga;* it was correlated by Roberts with the *Chonetes* and *Schizophoria* Zones at Mt. Morgan and is roughly equivalent to the *Prospira typa* var. *tellebangensis* Fauna at Cania. Roberts regarded the age of the *?Thomasaria voiseyi* Zone as upper Tournaisian.

Spirifer lirellus sol was described by Campbell and Engel (1963) from the Tulcumba Sandstone in the Werrie-Belvue district in New South Wales. The Tulcumba Sandstone contains oolitic limestone and overlies Upper Devonian strata either disconformably or with a low angle unconformity. Roberts considered the Tulcumba Sandstone fauna older than the *?Thomasaria voiseyi* Zone. Species that Roberts considered had resemblances to *Schellwienella* sp. nov. and *Antiquatonia* sp. nov. were stated by Roberts to occur in the middle part of the Namoi Formation which overlies the Tulcumba Sandstone. They suggest correlation with the *Prospira typa* var. *tellebangensis* Fauna. Roberts correlated the fauna from the middle part of the Namoi Formation with his *Schellwienella* cf. *burlingtonensis* faunal assemblage in the Gresford–Dungog district, which he considered late Tournaisian or early Viséan in age.

The two remaining zones of Roberts are of Viséan age and are younger than the *Prospira typa* var. *tellebangensis* Fauna.

Stratigraphic Relationships. The Cania Formation lies conformably on the Three Moon Conglomerate, the sharp lithological break at the base of the formation reflecting changes in contemporaneous vulcanicity from andesitic flows to acid pyroclastics.

Environment of Deposition. The sediments of the Cania Formations were deposited in warm shallow marine seas in which conditions at times were favour-

able to the formation of oolitic limestone. Contemporaneous vulcanicity was probably the principal source of clastic sediment.

YOULAMBIE CONGLOMERATE

Definition. The Youlambie Conglomerate is a new name proposed for the dominantly terrestrial Lower Permian sequence of conglomerate, arenite, siltstone, and acid volcanics, that disconformably overlies the Cania Formation in the Monto–Cania area and is overlain by the Yarrol Formation. It is equivalent in part at least, to the Burnett Formation in the Yarrol district.

The formation takes its name from Youlambie Creek approximately halfway between Monto and Cania.

Type Section. The type section is located outside the map area, near Youlambie Creek. It extends from the eastern bank of Youlambie Creek at m/r 41039195 (Monto 4-mile military sheet), north-east along the ridge crests to the south-western slopes of Mt. Coppin at m/r 41209217. Mt. Coppin is a basalt capped peak that conceals the upper parts of the formation. The section is continued along the ridge north-west of Youlambie Creek from m/r 41009200 to m/r 41089237 where the Youlambie Conglomerate is overlain by the Yarrol Formation. The two sections overlap. Thickness in the type area is estimated at 4,400 feet.

The older parts of the formation are well exposed in Three Moon Creek south from Cania, in Eight Mile Creek, on the ridges south-west of Cania, in Four Mile Creek, and in German Gully. Good exposures of the topmost 1,000 feet of the formation are found in Scrubby Mountain Creek and in Spring Creek south from Clonmel homestead.

Stratigraphic Succession. The base of the formation is marked by conglomerate containing abundant boulders of pink granite, aplite, quartz porphyry, feldspar porphyry, and rhyolite. Similar conglomerates are conspicuous throughout much of the lower 1,300 feet of the formation.

In the type section (Text-fig. 4), the basal 400 feet (unnamed unit *a*) comprises boulder to cobble conglomerate, conglomeratic mudstone, and interbedded coarse and medium-grained lithic and feldspathic arenite. Near Cania, this unit includes tillites and varves. Unit *b* is much finer-grained and in the type section consists of 420 feet of bluish-grey siltstone and medium and fine grained lithic and feldspathic arenite. *Eurydesma* and other marine pelecypods occur at one horizon in unit *b* west and north-west of Cania. Boulder, cobble, pebble and granule conglomerate, conglomeratic mudstone, and lithic and feldspathic arenite constitute most of unit *c* which is 500 feet thick in the type section. Coarse conglomerate and conglomeratic mudstone are far less abundant in unit *d* which is composed mostly of granule conglomerate; coarse, medium and fine-grained lithic and feldspathic arenite; and bluish-grey and black carbonaceous siltstone. Unit *d* has a thickness of approximately 1,900 feet near Youlambie Creek, and marine fossils including *Eurydesma* occur toward the top. The topmost 1,000 feet (unit *e*) in the type area is characterized by interbedded acid volcanics, well sorted conglomerates virtually free of "granitic" fragments, and by arenites which are frequently calcareous.

Lithology. The Youlambie Conglomerate was derived from a provenance of granitic rocks and acid to intermediate volcanics. Purplish or greenish fragments of andesitic volcanics, so abundant in the Famennian and Tournaisian deposits, are rare in the conglomerates and arenites, and no lithologies are purple weathering.

Most of the coarser conglomerates in units *a, b, c,* and *d* are polymictic and poorly sorted, and grade into conglomeratic mudstone. Fragments are mostly of acid and intermediate volcanics, pink granite, aplite, and quartz porphyry, feldspar porphyry, and indurated siltstone; other fragments are of grey granodiorite and diorite, basic lava, and low grade metamorphics. The coarsest conglomerates are found in unit *a* where granite and feldspar porphyry boulders up to 6 feet in diameter were noted. The conglomeratic mudstones consist of scattered subangular fragments in an unsorted and unstratified matrix forming up to 90 per cent. of the rock. In unit *a* at Cania, the conglomeratic mudstones are associated with sequences of rhythmically banded, bluish-grey or greyish-green varved siltstone showing slump structure and from 12 to 16 micro-graded beds to the inch. The bedding planes are disrupted by small "erratics". The varves and the associated conglomeratic mudstones, which probably represent tillites, are well exposed near the junction of Beatty Creek and Four Mile Creek, and at m/r 922368 immediately above the "falls" in Four Mile Creek. Some of the coarser conglomerates that are well sorted have a stilbite mineral cement.

In unit *e,* most conglomerates are well sorted. They are composed principally of acid volcanic and siltstone fragments.

Throughout the formation, the granule conglomerates are mostly well sorted and tightly packed. Argillaceous matrix is usually less than 10 per cent., and cements of opaline silica or reddish-brown ferruginous chlorite are common.

Poorly sorted unstratified arenites are abundant in units *a* and *c,* and occur also in unit *d.* In thin section, they are seen to consist of angular and subangular lithic grains, potash feldspar, plagioclase, and quartz, in an unsorted, brown, argillaceous matrix that forms up to 60 per cent. of the rock. Lithic fragments are predominantly of acid and intermediate volcanics. Most of these poorly sorted arenites are lithic labile types.

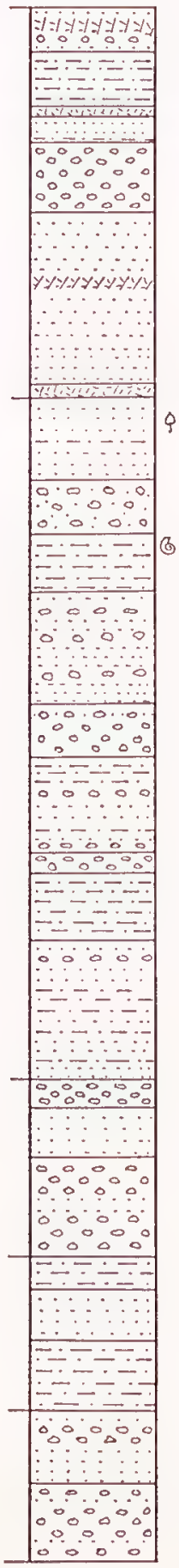
Well sorted, laminated, tightly packed arenites occur throughout the formation, but are best developed in units *b, d,* and *e.* In the hand specimen, they are tough bluish-grey rocks in which quartz is a prominent constituent. Thin section examination reveals that they consist of subrounded grains of quartz, potash feldspar, plagioclase, and lithic material in a brown agrillaceous matrix rarely exceeding 15 per cent. of the rock.

FIG. 4

YOULAMBIE CONGLOMERATE

Generalised Stratigraphic Section based on type section

Scale 1"= 600'



Unit e

Granule conglomerate and coarse and medium-grained lithic and feldspathic arenite; interbedded vitric and crystal rhyolitic tuff.

Fine-grained lithic and feldspathic arenite and siltstone.

Vitric and crystal rhyolitic tuff.

Medium-grained, calcareous lithic and feldspathic arenite.

Granule conglomerate and coarse-grained lithic and feldspathic arenite; some pebble conglomerate near base of unit.

Coarse, medium, and fine-grained lithic and feldspathic arenite, some calcareous; thin interbedded silicified vitric and crystal rhyolitic tuff.

Vitric and crystal rhyolitic tuff.

Medium and fine-grained lithic and feldspathic arenite; then pebbly conglomerate and plant-bearing siltstone bands.

Granule conglomerate and coarse and medium-grained lithic and feldspathic arenite; some pebbly mudstone towards top.

Silicified bedded blue tuffaceous siltstone and tough, fine-grained feldspathic arenite; rhyolitic vitric tuff.

Granule conglomerate and medium and coarse-grained lithic and feldspathic arenite; some cobble conglomerate and laminated siltstone bands.

Polymictic boulder and cobble conglomerate; pebbly mudstone and pebbly sandstone toward top.

Unit d

Coarse, medium and fine-grained lithic and feldspathic arenite; siltstone interbedded toward top.

Polymictic boulder, cobble, and pebble conglomerate.

Blue-grey siltstone and fine-grained lithic and feldspathic arenite.

Coarse and medium grained lithic and feldspathic arenite; some granule conglomerate and blue-grey siltstone.

Polymictic boulder, cobble, and pebble conglomerate and pebbly mudstone; abundant pink granite fragments.

Medium and fine-grained lithic and feldspathic arenite; thin interbedded pebble conglomerate beds.

Unit c

Polymictic pebble and cobble conglomerate, granule conglomerate, pebbly mudstone, and coarse and medium grained lithic and feldspathic arenite.

Blue-grey siltstone.

Unit b

Medium grained lithic and feldspathic arenite.

Blue-grey siltstone.

Unit a

Coarse and medium grained lithic and feldspathic arenite, and interbedded polymictic conglomerate, poorly sorted in part.

Polymictic boulder, cobble, and pebble conglomerate with abundant pink granite fragments; interbedded coarse and medium grained lithic and feldspathic arenite; some pebbly mudstone.

Marine fossil locality Plant fossil locality

Feldspathic labile types predominate. The quartz percentage is usually between 10 per cent. and 20 per cent. but ranges up to 50 per cent. in some specimens. It comprises a mixture of volcanic and plutonic types, except in unit *e* where it is mostly of volcanic origin. Large flakes of brown biotite are abundant in unit *e*. Opaline silica and reddish-brown ferruginous chlorite are the most prevalent mineral cements. Calcite cements are developed in some of the arenites in unit *e* in which there is a concentration of pilotaxitic textured andesitic lava fragments.

Load casting, graded bedding, slump structures and ripple marking are present in the siltstones in units *a, b* and *c*.

The rhyolitic volcanics in unit *e* are resistant, silicified, cream weathering rocks and include fluidal lavas and vitric and crystal tuffs.

Palaeontology. Plant stems and indeterminate carbonaceous material are found in many of the siltstones in units *b, d,* and *e*.

A marine pelecypod bed containing *Eurydesma* cf. *playfordi* Dickins, *Astartila* sp., *Schizodus minutus* Maxwell, and *Megadesmus* sp. nov. is a useful marker bed in unit *b* on the eastern side of the Four Mile Fault west and north-west of Cania. In the type area, *Eurydesma* cf. *playfordi, Schizodus minutus,* and *Promytilus cancellatus* Maxwell occur higher in the sequence in the upper part of unit *d*.

At m/r 937349 west of Cania township the rhacopterid-like plant *Cardiopteris* cf. *polymorpha* is found in siltstones overlying sandstones containing *Eurydesma* cf. *playfordi, Astartila* sp., and *Schizodus minutus.* This is the first recorded association of *Eurydesma* and *Cardiopteris,* which is usually regarded as indicative of Carboniferous strata. *Cardiopteris* is known also from the equivalent of the Youlambie Conglomerate on the Rockhampton 1:250,000 sheet area (Kirkegaard *et al.* 1966).

Noeggerathiopsis hislopi Bunbury occurs in unit *b* at m/r 959345 and in unit *d* in the type section. *Gangamopteris* sp. was found in unit *e* at m/r 032324 in Scrubby Mountain Creek. *Glossopteris* is rare in the Youlambie Conglomerate, and is known from only two localities on the Monto 1:250,000 sheet, both from the top of the unit in the Don River area, east of Rannes.

Age. The Youlambie Conglomerate is of probable Sakmarian age.

Eurydesma sp., *Promytilus* (?) *cancellatus,* and *Schizodus minutus* occur at Yarrol in the Burnett Formation, the age of which was considered by Maxwell (1964) to be Sakmarian. The goniatite *Uraloceras cancellatum* near the base of the overlying Yarrol Formation indicates an upper Sakmarian or lower Artinskian age for that formation.

The association of *Eurydesma* and rocks of glacial origin has been reported from the early Lower Permian in New South Wales, Tasmania, Western Australia, India, South Africa, and Argentina.

Correlation. The Youlambie Conglomerate is correlated with the Burnett Formation at Yarrol. Whereas the Burnett Formation is essentially a marine arenaceous-lutaceous sequence and overlies, without apparent break, marine Upper Carboniferous strata in the more eastern part of the exposed Yarrol Basin, the Youlambie Conglomerate is a much coarser, dominantly terrestrial sequence deposited disconformably on Lower Carboniferous beds along the western part of the basin.

Approximately 40 miles north-west of Cania, in the upper reaches of the Don River, the Youlambie Conglomerate crops out over a wide area and is overlain by fossiliferous equivalents of the Yarrol Formation; it is disconformable on Lower Carboniferous strata.

In the Mt. Morgan district, the Turner Creek Conglomerate (Maxwell 1953), which disconformably overlies marine Lower Carboniferous, is lithologically similar to the Youlambie Conglomerate and contains poorly sorted conglomerate rich in "granitic" fragments.

The Dinner Creek Conglomerate of the Stanwell district is terrestrial in origin and contains Permian plants, but is lithologically dissimilar to the Youlambie Conglomerate.

Stratigraphic Relationships. The Youlambie Conglomerate was deposited disconformably on the Lower Carboniferous strata throughout the western part of the Yarrol Basin. Despite the major time-break in deposition, no angular break was detected between the Lower Carboniferous and Lower Permian units. However, some overlap of the Cania Formation is indicated in the map area where in the west near Cania the conglomerate overlies unit *c* of the Cania Formation while further east it rests on unit *d*.

Environment of Deposition. Terrestrial environments appear to have prevailed in the western part of the Yarrol Basin in Sakmarian time. Conditions further east in the basin were marine during this period and at least two marine transgressions into the western part of the basin occurred.

Siltstones exhibiting graded bedding, slumping, load casting, and other features of turbidite deposits, were probably deposited under lacustrine conditions. Tillites and varves point to the existence of glacial environments during the early part of deposition of the formation.

Provenance of the sediments was probably an uplifted block of pre-Permian granite and acid volcanics presumably to the west or south-west of the basin. The acid volcanics and tuffaceous sedimentary rocks intruded by Carboniferous granites of the western part of the Auburn Complex, 40 miles west of Cania, represent one potential source area.

YARROL FORMATION

Introduction. The Lower Permian Yarrol Formation, was established by Maxwell (1959) for 1,700 feet of detrital limestone and arenite between the Burnett Formation and the Owl Gully Volcanics in

TABLE 3

STRATIGRAPHIC RANGE CHART OF DIAGNOSTIC SPECIES

	DAWES RANGE FORMATION				THREE MOON CONGLOMERATE	CANIA FORMATION				YOULAMBIE CONGLOMERATE					YARROL FORMATION
	Langtry G. Member	Milkman Ck. Member	South Kariboe Member	Denny Gully Member		Unit a	Unit b	Unit c	Unit d	Unit a	Unit b	Unit c	Unit d	Unit e	
Schizophoria pierrensis															
Cyrtospirifer reidi															
" subdisjuncta															
Cyrtiopsis aff. murchisonianus															
" aff. orbelianus															
Gürichella ? sp.															
"Gürichella" sp. nov.															
Mucrospirifer aff. kennedyensis															
Camarotoechia cf. lucida															
Nayunella sp. nov.															
Rhipidomella ? sp.															
Mesoplica aff. praelonga															
Sentosia cf. sp. nov. a.															
Athyris randsi															
Cleiothyridina aff. reticulata															
Leiorhynchus sp. nov. a.															
Pugnoides sp. nov.															
Retichonetes sp. nov.															
Avonia aff. niger															
Sentosia sp. nov. a.															
Cyrtospirifer sinensis var. australis															
Athyris sp. nov.															
Avonia sp.															
Sentosia sp. nov. b.															
Tenticospirifer grandis															
Schizophoria aff. resupinata															
Leptagonia sp.															
"Tylothyris" sp.															
"Gürichella" kennedyense															
Athyris sp.															
Perissothyris aff. masonensis															
Axiodeania ? sp.															
Phricodothyris ? sp.															
Eoschizodus sp.															
cf. Cypricardinia sp.															
Panenka cf. porteri															
Myalina sp. nov.															
Polidevcia cf. tulcumbensis															
Schellwienella sp. nov.															
Rugosochonetes kennedyensis var. magnus															
Pustula sp. nov.															
Prospira prima															
Spirifer lirellus sol															
Cleiothyridina biconvexa															
Brachythyris sp.															
Camarotoechia sp.															
Schizophoria verulamensis															
Rhipidomella australis															
Leptagonia cf. analoga															
Plicochonetes sp.															
Antiquatonia sp. nov.															
Prospira typa var. tellebangensis															
Prospira aff. striatoconvoluta															
Martinia productoides															
Brachythyris aff. solida															
"Tylothyris" sp.															
Cleiothyridina transversa															
Cleiothyridina australis															
Phricodothyris cf. uniplicata															
Palaeacis cf. cuneiformis															
Eurydesma sp.															
Schizodus minutus															
Astartila sp.															
Megadesmus sp.															
Eurydesma cf. hobartense															
Lissochonetes yarrolensis															
Taeniothaerus subquadratus															
Strophalosia preovalis															
Linoproductus cf. lyoni															
Anidanthus springsurensis															
Terrakea cf. pollex															
Cancrinella cf. farleyensis															
Grantonia cf. hobartensis															
Trigonotreta sp.															
Ingelarella ovata															
Ingelarella profunda															
Uraloceras cancellatum'															

the Yarrol Syncline south-east of Monto. The type area, designated by Maxwell, is near Yarrol homestead, 16 miles south-east of Monto.

In the Monto-Cania area, the formation overlies the Youlambie Conglomerate, and crops out on the western limb of the north-west trending Spring Creek Syncline. It comprises 1,600 feet of siltstone and fine-grained arenite, and interbedded limestone, medium-grained lithic arenite, chert, and andesitic lava. In contrast to the underlying Youlambie Conglomerate, the formation crops out poorly, and occupies mostly low strike-ridges. The best exposures in the map area are in Spring Creek and in Scrubby Mountain Creek.

Stratigraphic Succession. The Yarrol Formation in the south-eastern part of the map area comprises a monotonous sequence of black calcareous siltstone and fine arenite. Lenses of grey coquinitic limestone occur in the basal 100 feet and grade laterally into richly fossiliferous silty limestone and calcareous siltstone.

There is a sharp lithological change at the base of the formation in Spring Creek where black siltstones rest directly on buff-weathering acid, vitric and crystal tuff of the Youlambie Conglomerate. At m/r 071289, a thin black andesite lava marks the base of the formation; near Mt. Coppin 6 miles south-east of Clonmel homestead, a basal coquinitic limestone is developed.

The base of the overlying Owl Gully Volcanics is marked by a change from black siltstone to black and green andesitic volcanics. The boundary is gradational and thin andesitic lavas occur in the upper parts of the Yarrol Formation.

Lithology. The siltstones and fine-grained arenites are black to brownish-black and calcareous. Particularly on weathered surfaces, they show an unusual texture consisting of darker, irregularly-shaped "clasts" in a slightly lighter-coloured matrix. In thin section, the clasts are seen to be similar in composition to the enclosing matrix but to have a darker brown colour; boundaries between the "clasts" and matrix are gradational and indistinct. The texture may be the result of worm action which has obliterated much of the bedding. Interbedded siltstones and fine arenites which do not have this texture are frequently graded bedded.

The interbedded medium-grained arenites are not well sorted and consist of andesitic volcanics and plagioclase, mostly andesine, in a dark-brown, calcareous, tuffaceous matrix which may form up to 40 per cent. of the rock, with lithic grains usually predominating over feldspars. The rocks are lithic labile arenites in the terminology of Crook (1960). Quartz is a minor constituent in the medium-grained arenites but is abundant as fine subangular grains in certain of the siltstones and fine-grained arenites.

Andesitic lavas in the formation are similar to the lavas in the Owl Gully Volcanics.

Fauna and Flora. Rich brachiopod-bryozoan assemblages in the Spring Creek and Scrubby Mountain Creek areas contain the following species:—*Lissochonetes yarrolensis* Maxwell, *Taeniothaerus subquadratus* var. *cracowensis* Hill, *Strophalosia preovalis* Maxwell, *Linoproductus* cf. *lyoni* Prendergast, *Cancrinella* cf. *farleyensis* (Etheridge and Dun), *Terrakea pollex* Hill, *Anidanthus springsurensis* (Booker), *Grantonia* cf. *hobartense* Brown. *Trigonotreta* sp., *Ingelarella ovata* Campbell, *Ingelarella profunda* Campbell, *Cancellospirifer* sp., *Psilocamara* sp., *Deltopecten limaeformis* Morris, *Stutchburia costata* (Morris), *Parallelodon* sp., *Myonia* sp., *Conocardium* sp., *Astartila* sp., *Uraloceras cancellatum* Dear, *Polypora* spp., and *Fenestella* spp.

Most of the assemblages are preserved in calcareous siltstone and silty limestone in the lower half of the formation. The upper half of the unit is comparatively poorly fossiliferous.

Age. Maxwell regarded the Yarrol Formation as late Sakmarian in age. The presence of the goniatite *Uraloceras cancellatum* indicates an upper Sakmarian or lower Artinskian age (Dear, 1966). *U. cancellatum* has close affinities with *U. pokolbinense* (Teichert) from the Farley Formation in New South Wales, and with upper Sakmarian and lower Artinskian species from the Ural Mountains in Russia.

Regional Distribution and Correlation. The Yarrol Formation in the map area is slightly finer grained and contains a lower proportion of interbedded limestone than in the Yarrol district, but overall lithologies, fauna, and thickness are similar in the two areas.

Approximately 40 miles north-west of Cania, in the Don River area, fossiliferous equivalents of the Yarrol Formation overlie the Youlambie Conglomerate and pass up into a thick sequence of andesitic volcanics, equated with the Owl Gully Volcanics.

The fauna of the Yarrol Formation indicates approximate correlation with the upper Sakmarian or lower Artinskian fauna in the Camboon Andesite and the overlying Buffel Formation in the south-eastern part of the Bowen Basin on the western part of the Monto 1:250,000 sheet area.

Stratigraphic Relationships. The abrupt lithological change at the base of the formation may indicate a minor disconformity reflecting major changes in environment from dominantly terrestrial sedimentation with a provenance of acid volcanics to marine sedimentation in which the source was principally contemporaneous basic volcanics.

The Yarrol Formation grades upwards into the Owl Gully Volcanics.

Environment of Deposition. Shallow water conditions prevailed during the deposition of the richly fossiliferous lower half of the formation. The seas may have deepened slightly during the deposition of the upper half of the formation, as indicated by the paucity of faunas and the graded-bedded and poorly sorted arenites.

OWL GULLY VOLCANICS

Introduction. The name Owl Gully Volcanics was introduced by Maxwell (1959) for the andesitic volcanic sequence overlying the Yarrol Formation in the Yarrol Syncline. The Syncline closes in the Volcanics and a thickness of at least 5,000 feet is exposed.

Equivalents of the Owl Gully Volcanics are found in the eastern part of the map area where over 5,000 feet of andesitic volcanics and interbedded siltstone overlie the Yarrol Formation in the Spring Creek Syncline. Scattered marine fossils of Permian age are present. As at Yarrol, the top of the formation is not exposed.

The best exposures are found in Apple Tree Creek, Scrubby Mountain Creek, and in Tulloch Gully. Generally, outcrop is poor.

Stratigraphic Succession. The formation in the Spring Creek Syncline comprises an undifferentiated sequence of andesitic volcanics, with some interbedded siltstone and lithic arenite that are similar to the rocks of the Yarrol Formation. Accurate estimation of thickness is hampered by poor outcrop and the paucity of dip and strike information. The thickness exposed in Apple Tree Creek is estimated at a minimum of 5,000 feet.

Lithology. Lithologies in the formation include andesitic lava, lithic and lapilli tuff, agglomerate, and calcareous siltstone and lithic arenite.

Flows are far more common than pyroclastics. The andesitic lavas are black, greyish-green, or dark green, porphyritic, and commonly vesicular. In thin section, they are seen to consist of phenocrysts of andesine, oligoclase, clinopyroxene, and occasionally olivine, in a fine-grained pilotaxitic, trachytic, or felsitic textured groundmass. Glomeroporphyritic textures are common. Olivine is wholly or partially altered to serpentine. In the dark-brown groundmass, epidote and chlorite are far less conspicuous than in the older Devonian and Carboniferous andesites. Vesicles are infilled by chlorite, zeolite, prehnite and calcite. No pillow-lava structures were observed and few of the volcanics are purple weathering.

Interbedded siltstones are identical to those in the Yarrol Formation and constitute less than one-fifth of the unit. Associated medium-grained lithic arenites are composed of andesitic detritus, and are graded bedded and poorly sorted.

Fauna and Flora. Marine fossils are rare in the unit, but include a single specimen of an indeterminate nautiloid, one specimen of the Permian pelecypod *Atomodesma,* and numerous crinoid stems, all from high in the exposed part of the formation at m/r 041390, and one specimen of *Astartila* (?) sp. from m/r 008373.

Age. The impoverished fauna gives a Permian age and the stratigraphic position of the Owl Gully Volcanics indicates a Lower Permian age.

Stratigraphic Relationships. The Owl Gully Volcanics lie conformably on the Yarrol Formation and represent the youngest rocks deposited in the Yarrol Basin on the Monto sheet. Sedimentation in the main part of the basin probably came to a close after the outpouring of the Volcanics.

The Volcanics are overlain with marked unconformity by the Triassic Muncon Volcanics.

Environment of Deposition. The Owl Gully Volcanics are thought to have accumulated in a marine environment similar to that existing during the deposition of the upper part of the Yarrol Formation.

MUNCON VOLCANICS

Definition. This is a new name proposed for the terrestrial volcanics of Triassic age that unconformably overlie the Yarrol Basin sequence and the granite in the map area.

The Volcanics derive their name from Mt. Muncon, approximately 3 miles south-west of Cania, where they rest on granite and hornfelsed Upper Palaeozoic rocks and dip unconformably beneath the cliffs of the Precipice Sandstone.

They crop out extensively in the south-western part of the map area, and also north-west of Beigogo homestead where they rest unconformably on the Owl Gully Volcanics.

Type Locality. North of Mt. Muncon, in the area adjacent to the unnamed creek running into Oaky Creek at m/r 949319. The base of the volcanics is exposed in the creek at m/r 946318, and to the south near Mt. Muncon, the Volcanics are overlain by the Precipice Sandstone.

Stratigraphic Succession. Plant-bearing siltstones exposed at the base of the Volcanics in a tributary of Oaky Creek at m/r 946318 are the only sedimentary rocks observed in the unit in the Cania area. The remainder of the unit, as developed south-west of Cania and north-west of Beigogo, comprises an undifferentiated sequence of basic lavas and minor interbedded agglomerate and lapilli tuff. No acid flows or pyroclastics are present but trachytic dykes are common. Thickness cannot be estimated accurately because of the lack of accurate dip and strike data and the removal by erosion of part of the Volcanics prior to the deposition of the Precipice Sandstone. At least 500 feet are exposed south-west of Cania.

North of the map area, in Kroombit Creek, trachytic lavas and pyroclastics are well developed in the upper part of the Volcanics.

Lithology. Most of the lavas are fine-grained basalts which are black when fresh but weather dark brown or brownish-purple. Many are vesicular with red or white zeolites occupying the vesicles. In the hand specimen, the lavas often contain copper-coloured fine phenocrysts of mafic mineral; felspar is inconspicuous as phenocrysts. Microscopically, the lavas contain scattered phenocrysts of andesine and labradorite and more numerous phenocrysts of clinopyroxene and olivine both of which are partly altered to colourless serpentine, reddish-brown iddingsite, and hematite. The fine-grained groundmass has a pilotaxitic texture. Iddingsite is abundant in the groundmass replacing granules of mafic mineral.

Siltstones at the base of the Volcanics are khaki coloured and contain abundant macerated carbonaceous material.

Flora and Age. Plant fossils from the base of the Volcanics include *Neocalamites* sp., *Dicroidium eskensis* Walkom, and *Dicroidium* sp., which indicate a Triassic age.

Correlation. The Volcanics are correlated with a thick sequence of siltstone and andesitic volcanics of Triassic age encountered in the Amalgamated Petroleum No. 1 Well, on the western side of the Mulgildie Fault approximately 28 miles south-south-east of Cania. These rocks lie on Upper Permian granite and are overlain by the Precipice Sandstone; they may be continuous at depth below the Mulgildie Basin rocks with the Muncon Volcanics south-west of Cania.

Stratigraphic Relationships. The Volcanics occupy broad shallow synclinal basins, one south-west of Cania and another in the major outcrop-area extending north of the map area from Beigogo station to beyond Kroombit Creek (Fig. 8). Dips usually are less than 15 deg. and in both outcrop-areas the Volcanics are overlain by almost flat-lying Precipice Sandstone. To some extent, the depositional areas of the Volcanics may have been controlled by Upper Permian or Triassic high angle faults; this is discussed in the section on structural geology.

Environment of Deposition. The Volcanics are terrestrial and were probably extruded over a very irregular land surface.

PRECIPICE SANDSTONE

The basal unit within the Jurassic Mulgildie Basin sequence is a cliff-forming, cross-bedded quartz arenite which lies with marked unconformity on the Upper Palaeozoic and Triassic rocks south of Cania. It is correlated with the Precipice Sandstone of the Surat Basin sequence and is overlain by equivalents of the Evergreen Formation which include an oolitic-ironstone bed. Then follows the Hutton Sandstone equivalent, and the Mulgildie Coal Measures which contain Jurassic Plant fossils.

The Precipice Sandstone crops out strongly south of Cania where it forms prominent sandstone cliffs up to 250 feet high. Dips are to the south at 2 deg. or 3 deg. The unit consists of clean, medium and fine-grained, quartz arenite and interbedded quartz pebble conglomerate and white micaceous siltstone. No plants were found in the unit.

The age of the formation is Lower Jurassic.

Tertiary Basalt

Cappings of Tertiary olivine basalt occupy extensive low plateaux on the South Kariboe Creek side of the Dawes Range. The basalt is much less extensive on the Three Moon Creek side of the range and restricted to thin scattered cappings on the higher hills. Post-basalt erosion appears to have been more active in the drainage basin of Three Moon Creek than in that of South Kariboe Creek.

West of the map area, fresh basalt overlies the terrestrial Tertiary sediments of the Callide Basin and laterite of Tertiary age.

Intrusive Rocks

South-west of Cania, the Youlambie Conglomerate is intruded by granite, granodiorite, and adamellite, of the north-eastern part of the Auburn Granite Complex which is overlain by the Muncon Volcanics. Radiometric dating of a sample from the Cania Gorge 3½ miles south of Cania indicates an Upper Permian age (A. W. Webb, pers. comm.).

Dolerite and feldspar porphyry sills and dykes intrude the Upper Palaeozoic sequence over much of the map area. They do not intrude the Muncon Volcanics or Precipice Sandstone and pre-date the granites of the north-eastern Auburn Complex.

A younger series of resistant trachyte dykes intrude the Upper Palaeozoic formations and the Muncon Volcanics, but not the Precipice Sandstone. The dykes are probably related to the extrusion of the trachytic volcanics in the upper part of the Muncon Volcanics cropping out near Kroombit homestead.

STRUCTURAL GEOLOGY

Introduction. Sedimentation in the Yarrol Basin in the Cania area came to a close probably in the late-Lower or early-Upper Permian. The basin sequence was then folded along a series of north-west axes during a strong orogeny that commenced in the Upper Permian and may have extended into the early Triassic. The north-eastern part of the Auburn Complex was emplaced in the Upper Permian; collapse of the country rock around the margin of the granite may have resulted in the formation of the complex network of high-angle faults in the south-eastern part of the map area. During the main orogeny, the Yarrol Basin succession was thrust south-westwards towards the western margin of the basin.

In the Triassic, epeirogenic uplift resulted in renewed movement along some of the earlier-formed faults, and in the formation of additional high angle faults. This epeirogenic phase of movement may have partly controlled the areas of deposition of the Muncon Volcanics; it continued long enough to cause some major displacements of the Volcanics. A third period of faulting, which occurred in post-Middle Jurassic time, involved probable "Saxonian" type basement-block adjustment, and was confined to movement along the Mulgildie Fault.

Folding. The Spring Creek Syncline is a broad north-west trending structure within the Upper Palaeozoic rocks in the eastern part of the area, and extends from Beigogo station beyond the south-eastern part of the area to Monal Creek near Monto. The synclinal axis is occupied by Owl Gully Volcanics, the youngest Yarrol Basin rocks exposed in the Monto-Cania region. The axis is truncated on the south-east by the Three Moon Fault, and on the north-east by the Bargogo Fault. Dips on both flanks average 30 deg. The synclinal structure is not reflected by the Muncon Volcanics which unconformably overlie the Owl Gully Volcanics in the synclinal axis west and north-west of Beigogo station, and dip to the north-west.

The Kroombit Oaky Anticline is a faulted anticlinal structure within Upper Devonian and Lower Carboniferous strata, developed on the western flank of the Spring Creek Syncline between the Mulgildie Fault and the Blue Hills Fault. The anticlinal axis is concealed by north-west trending thrust faults on both sides of the Kroombit Oaky Fault.

FIG.5.

REGIONAL GEOLOGY – CANIA AREA

SCALE OF YARDS
0 10,000 20,000

LEGEND

- Tertiary
- Jurassic
- Triassic
- Granite
- Lower Permian
- Upper Carboniferous
- Lower Carboniferous
- M. & U. Devonion

Kroombit
Kroombit
Ck.
BARGOGO
Karibee
North
Ck.
South Karibee
Ck.
FAULT
THREE
Monal
CANIA
Three
Ck.
Cattle
MULGILDIE
Monal
Ck.
MOON
Ck.
Youlambie
Moon
Ck.
TELLEBANG
FAULT
ANTICLINE
MONTO
DAKIEL
YARROL
SYNCLINE
Ck.
New Cannindah
Spicers
Old Cannindah
Yarrol

Strata on the western limb of the Kroombit Oaky Anticline are exposed east of the Mulgildie Fault from Comet Gully south-east to the junction with the Blue Hills Fault. The beds are displaced by the Kroombit Oaky Fault which separates the lower part of the Dawes Range Formation west of the Fault from Cania Formation on the east. Dips on the exposed western limb average 30 deg. Comparatively low dips, rarely exceeding 15 deg., persist over most of the broad eastern limb for over a mile transverse to the anticlinal axis. Minor local reversals of dip are found in the Three Moon Conglomerate in Kroombit Oaky Creek. The Kroombit Oaky Fault cuts across the fault separating the eastern and western limbs, and divides the eastern limb into eastern and western outcrop-areas occupied by Upper Devonian and Lower Carboniferous strata respectively. Sub-horizontal strata, presumably adjacent to the anticlinal axis, are exposed immediately east of the Mulgildie Fault in South Kariboe Creek. The Anticline appears to represent a strongly asymetric structure with a narrow, comparatively steep western limb and broad eastern limb. Persistent south-eastern dips near Three Moon Creek and First Crossing Creek indicate a possible axial plunge to the south-east.

The only well defined fold structure south-west of the Mulgildie Fault is the Middle Creek Anticline, bordered by the South Kariboe and Mulgildie faults respectively, and occupied by the Three Moon Conglomerate and Cania Formation. The north-west trending anticlinal axis is truncated to the north-west by the South Kariboe Fault, and to the south-east in Kariboe Creek by another fault. Strata of the Three Moon Conglomerate on the western limb are exposed between these two faults in South Kariboe Creek and Middle Creek; dips are mostly between 10 deg. and 15 deg. On the eastern limb, the average dip increases from 5 deg. in South Kariboe Creek to 25 deg. near Comet Gully. The Middle Creek Anticline may represent the crestal part of the Kroombit Oaky Anticline thrust south-westward along the South Kariboe Fault.

Most of the remaining Upper Palaeozoic strata on the south-western side of the Mulgildie Fault dip easterly and north-easterly, and occupy the broad eastern limb of a major anticlinal structure intruded by granite. North-east trends in the Upper Devonian and Lower Carboniferous rocks adjacent to South Kariboe Creek and southerly dips in the Cania Formation and Youlambie Conglomerate near Highfields station may reflect the presence of an anticlinal structure plunging to the south-east, on the south-western side of the Four Mile Fault; the hypothetical western limb is concealed by granite and by younger Mesozoic and Tertiary cover. Alternatively, the changes in strike in the south-western part of the area may reflect block re-orientation around the margin of the granite.

Faulting. The upper Palaeozoic country rock around the margin of the granite in the south-western part of the map area has been fractured by a set of north-west trending high-angle faults, the more important of which are the Karrawong, Four Mile, Fig Tree, Lee Yen, Cania, and Langtry Gully faults. These faults truncate another set of west-trending faults, some of which have throws of several thousand feet.

On both sets of faults, the downthrown block is towards the boundary of the granite, i.e., on the south-west along the north-west faults and on the south along the west-trending faults. The only exception is the Karrawong Fault along which the south-western block has been upthrown.

The north-west faults are marked by prominent fault breccias and occasional felsite intrusions. The gold-copper mineralisation at Cania appears localized along these faults and associated minor fractures. Comparatively minor brecciation occurs along the west-trending faults. The numerous intrusions of diorite and dolerite that have been emplaced in the Upper Palaeozoic rocks are independent of both sets of faults, and are displaced by the faults.

Apparent vertical movement along the north-west faults varies considerably because of the presence of the west-trending faults that terminate against the north-west set. Overall, the displacements decrease from south-east to north-west, and the faults either die out to the north-west or terminate in outcrop against the South Kariboe Fault which may represent a possible thrust. Along the Fig Tree Fault, the apparent vertical displacement between the South Kariboe and Denny Gully members east of South Kariboe Creek is only a few hundred feet; this displacement increases to over 5,500 feet between the Dawes Range Formation and the Youlambie Conglomerate in the upper parts of Fig Tree Gully. However, several hundred yards to the south-east where the same fault separates Cania Formation and Youlambie Conglomerate, the apparent upthrow is little more than 2,000 feet, over 3,000 feet of section being cut out by a west-trending fault truncated by the Fig Tree Fault near Fig Tree Gully. Similarly, along the Cania Fault, the amount of section concealed is approximately 2,500 feet near Cania township, in excess of 4,500 feet at Mt. Rose, but less than 500 feet 1 mile north-north-west of Mt. Rose. The west-trending faults separating the Dawes Range Formation from the Cania Formation in Denny Gully, Fig Tree Gully and Langtry Gully all have downthrows on the southern block of more than 2,500 feet.

The two sets of high-angle faults in the south-western part of the map area may have formed as the result of collapse of the country rock around the north-eastern margin of the Auburn Complex. To compensate for the decreased vertical movement north-westwards along the north-west faults, the transverse fractures formed within the fault blocks and dropped down successive blocks on the southern side, the side nearest the granite. Principally, by means of the two sets of faults, the late Upper Devonian to Lower Permian rocks around the north-eastern margin of the granite pass to the north-west into the Middle and early Upper Devonian rocks exposed extensively north-west of the map area (Text-fig. 5).

Movement along the Four Mile Fault, probably in the late Triassic has dropped the Muncon Volcanics down to the south-west but has not affected the Mulgildie Basin rocks.

The Mulgildie Fault was first mapped by Reid (1927) in the Monto-Mulgildie area where it separates the Yarrol Basin rocks on the east from the Mulgildie Basin sequence to the west. From Monto northwards as far as Scrubby Mountain Creek, the Fault forms the eastern boundary of the Mulgildie Basin sequence; the Precipice Sandstone along the Fault has been upturned forming a prominent resistant ridge for several miles south-east of Scrubby Mountain Creek. Post Middle Jurassic movement along the Fault east of Mulgildie conceals the Jurassic section underlying the Mulgildie Coal Measures. From east of Mulgildie to Scrubby Mountain Creek, the Fault maintains a uniform north-north-west trend.

The Mulgildie Fault is difficult to trace north-west from Scrubby Mountain Creek, because the displacements are entirely within the Upper Palaeozoic sequence and several splay faults are given off. The fault separating the Upper Devonian and Lower Carboniferous sequences in the western tributary gullies of Kroombit Oaky Creek and further north-west in South Kariboe Creek and Middle Creek is interpreted as the probable continuation of the Mulgildie Fault. It is marked along much of its length by a prominent fault breccia.

Vertical displacements of the Upper Palaeozoic rocks along the Fault vary considerably. In Boolgal Creek, where the Fault separates Youlambie Conglomerate and Dawes Range Formation, over 8,000 feet of section is concealed. However, 1 mile to the north-west in Three Moon Creek, the amount of section cut out is little more than 200 feet, even though dips are in opposite directions on either side of the Fault. This great reduction is brought about by the Mulgildie Fault truncating a west-trending fault on the western block separating Upper Devonian from Lower Carboniferous and Lower Permian strata. North-westwards from Comet Gully the Fault separates the upper part of the Kroombit Beds and lower half of the Dawes Range Formation from Cania Formation and Three Moon Conglomerate, and between 4,000 and 5,000 feet of section is concealed.

The Mulgildie Fault may have formed initially by collapse of the Upper Palaeozoic country rock around the margin of the Auburn Complex, and may be related to the north-west trending faults further west. Alternatively, it may represent a major thrust.

North-west from Scrubby Mountain, four major faults—the South Kariboe, Kroombit Oaky, Blue Hills and Bargogo faults, respectively—splay from the Mulgildie Fault. They differ from the Mulgildie Fault and the other high angle faults further west in having the relative downthrow on the north-east. Fault breccias are far less conspicuous than along the Mulgildie Fault and the north-west trending faults further west.

For most of its length, the South Kariboe Fault separates the purplish-weathering rocks of the Three Moon Conglomerate from the Dawes Range Formation and Kroombit Beds to the south-west; the amount of section concealed ranges from 2,500 feet to 4,000 feet. The Fault truncates the axis of the Middle Creek Anticline and cuts out the western limb south-eastwards from South Kariboe Creek.

The Kroombit Oaky Fault extends for a distance of almost nine miles from south of Boolgal Creek to north-west of Middle Creek. For its entire length, it separates the lower part of the Dawes Range Formation and Kroombit Beds from Lower Carboniferous strata of the Three Moon Conglomerate and Cania Formation. Near Three Moon Creek, it cuts across the faulted axis of the Kroombit Oaky Anticline. In Kroombit Oaky Creek, where the Fault separates the Langtry Gully Member and the Three Moon Conglomerate, over 3,000 feet of section is concealed while further south, in Boolgal Creek, over 5,000 feet of section is missing.

The maximum displacement along the Blue Hills Fault is in the upper parts of Kroombit Oaky Creek, where over 3,000 feet of section has been concealed.

The Bargogo Fault can be traced for a distance of over 10 miles from near Scrubby Mountain north-north-westwards to Middle Creek. It truncates the axis of the Spring Creek Syncline near Three Moon Creek, bringing Owl Gully Volcanics on the eastern limb into contact with Youlambie Conglomerate on the western limb. Movement in the late Triassic has resulted in the Muncon Volcanics being dropped down on the north-eastern side of the Fault. The amount of section concealed varies from approximately 4,000 feet near Scrubby Mountain to over 10,000 feet in Three Moon Creek.

These four major faults splaying from the Mulgildie Fault may represent high angle faults downthrown on the north-east, or alternatively a series of thrust faults. The truncation of the axes of the Middle Creek Anticline and Spring Creek Syncline does indicate a possible strong horizontal component of movement for the South Kariboe and Bargogo faults respectively. Movement affecting the Muncon Volcanics along the Bargogo Fault however was almost certainly under tension. The Bargogo Fault continues north-west of the map area and forms the western boundary of the large synclinal basin occupied by the Muncon Volcanics north of the map area.

Both the high angle faults around the margin of the Auburn Complex and the splay faults from the Mulgildie Fault appear to have partly controlled the depositional areas of the Muncon Volcanics. The progressive dropping-down of blocks towards the granite margin appears to have been partly responsible for the formation in the Triassic of a topographic low on the south-western side of the Mulgildie Fault. Similarly the progressive dropping-down of blocks to the north-east by the splay from the Mulgildie Fault contributed to the formation of another topographic low north of the map area.

On the eastern limb of the Spring Creek Syncline, the Three Moon Fault separates the Owl Gully Volcanics from Cania Formation and Youlambie Conglomerate, and conceals over 7,000 feet of the Lower Carboniferous and Lower Permian section in Apple Tree Creek. The Fault is downthrown on the

south-western side. Probable late-Triassic movement along the Fault has dropped the Muncon Volcanics down on the south-western side but this displacement is of considerably less magnitude than the displacement of the Upper Palaeozoic rocks. South-east of the map area, the Three Moon Fault cuts across the axis of the Spring Creek Syncline on to the western limb, and runs into the Mulgildie Fault near Monto.

Regional Structure. The Spring Creek Syncline dies out to the south-east near Monto, between the intersection of the Mulgildie and Three Moon faults. East and south-east of the map area, the Syncline is bordered to the east by a complex anticlinal structure, the Tellebang Anticline of Maxwell (1960), the axial portion of which is occupied mostly by late Upper Devonian and lower Tournaisian equivalents of the Dawes Range Formation and Three Moon Conglomerate respectively (Text-fig. 5).

Upper Palaeozoic sedimentation differed considerably on opposite sides of the Tellebang Anticline. In most of the area to the west, the Youlambie Conglomerate rests disconformably on upper Tournaisian strata of the Cania Formation. The only Viséan strata present are in the area east and south-east of Monto where the thick lower Viséan limestone of the Old Cannindah area (Maxwell 1961) is disconformably overlain by the Youlambie Conglomerate. No Upper Carboniferous strata are known west of the Tellebang Anticline.

To the east of the Tellebang Anticline is the north-north-west trending Yarrol Syncline which exposes Owl Gully Volcanics in its axial region near Yarrol homestead. In this syncline, a thick lower, middle, and probable upper Viséan sequence is disconformably overlain by over 6,000 feet of marine Upper Carboniferous strata which appear to pass conformably upwards into the Lower Permian Burnett Formation, correlated with the Youlambie Conglomerate further west.

REGIONAL GEOLOGICAL HISTORY

Shallow marine seas covered the western part of the Yarrol Basin in the Givetian, and thick limestones at the base of the Kroombit Beds were deposited. Marine sedimentation appears to have continued uninterrupted into the Frasnian when thick sequences of submarine basic volcanics accumulated. In the lower or early upper Famennian, the cross-stratified arenites at the base of the Dawes Range Formation were deposited in the Cania area following a decline in the basic vulcanicity. Periods of strong vulcanicity alternated with periods of relative quiescence during the deposition of the remainder of the Dawes Range Formation in the upper Famennian.

Probable late Upper Devonian-early Tournaisian uplift is reflected in the western part of the basin by the abundant rudaceous sediments of the Three Moon Conglomerate. The Tournaisian is characterized by alternating episodes of acidic and basic vulcanicity. In the Upper Tournaisian, conditions were favourable for the development of oolitic limestones which appear earlier in the western part of the basin than in the east. During the Tournaisian, the seas appear to have deepened eastwards, and the Tournaisian sequence in the east is overall considerably finer grained than in the west.

Early in the Viséan, the shallow seas began to withdraw from the western part of the basin and sedimentation ceased in the Cania area until the Lower Permian. The seas shallowed slightly in the Viséan in eastern parts of the basin in the Yarrol-Dakiel area, but the seas did not withdraw until the upper Viséan.

The seas returned to the eastern parts of the basin in the Upper Carboniferous, but the Upper Carboniferous sedimentation did not extend westward to the Monto-Cania region.

Late Carboniferous-early Permian uplift resulted in the deposition of the dominantly terrestrial Youlambie Conglomerate along the western part of the basin in the Sakmarian; some of these Sakmarian deposits are of possible glacial origin. In the Yarrol-Dakiel area, marine sedimentation appears to have been continuous from the Upper Carboniferous into the Sakmarian. Marine incursions into the western part of the basin occurred during the Sakmarian.

In the lower Artinksian clastic sediments and limestones were deposited in shallow seas that covered both the eastern and western parts of the basin. Sedimentation in the basin ceased probably in the late-Lower or early-Upper Permian after the deposition of the Owl Gully Volcanics.

The Yarrol Basin rocks were folded during a strong orogeny which commenced in the Upper Permian and may have continued into the Lower Triassic. The north-eastern part of the Auburn Complex was emplaced in the Upper Permian, probably during the later stages of the orogeny. The basin was uplifted in the Triassic and the post-tectonic Muncon Volcanics were outpoured in the Middle or Upper Triassic over an irregular land surface.

In the Jurassic, the Mulgildie Basin succession was deposited unconformably on the Triassic and Upper Palaeozoic rocks. Movement along the Mulgildie Fault, probably related to basement block-movement, dropped the Mulgildie Basin rocks down on the west, in post Middle Jurassic time.

Olivine basalts were outpoured over the land surface in the late Tertiary, following, a period of lateritisation.

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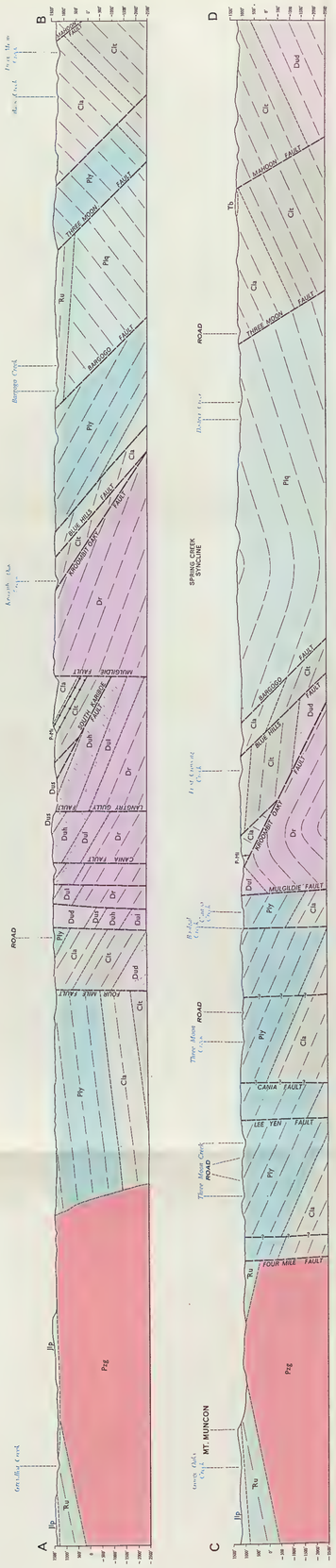
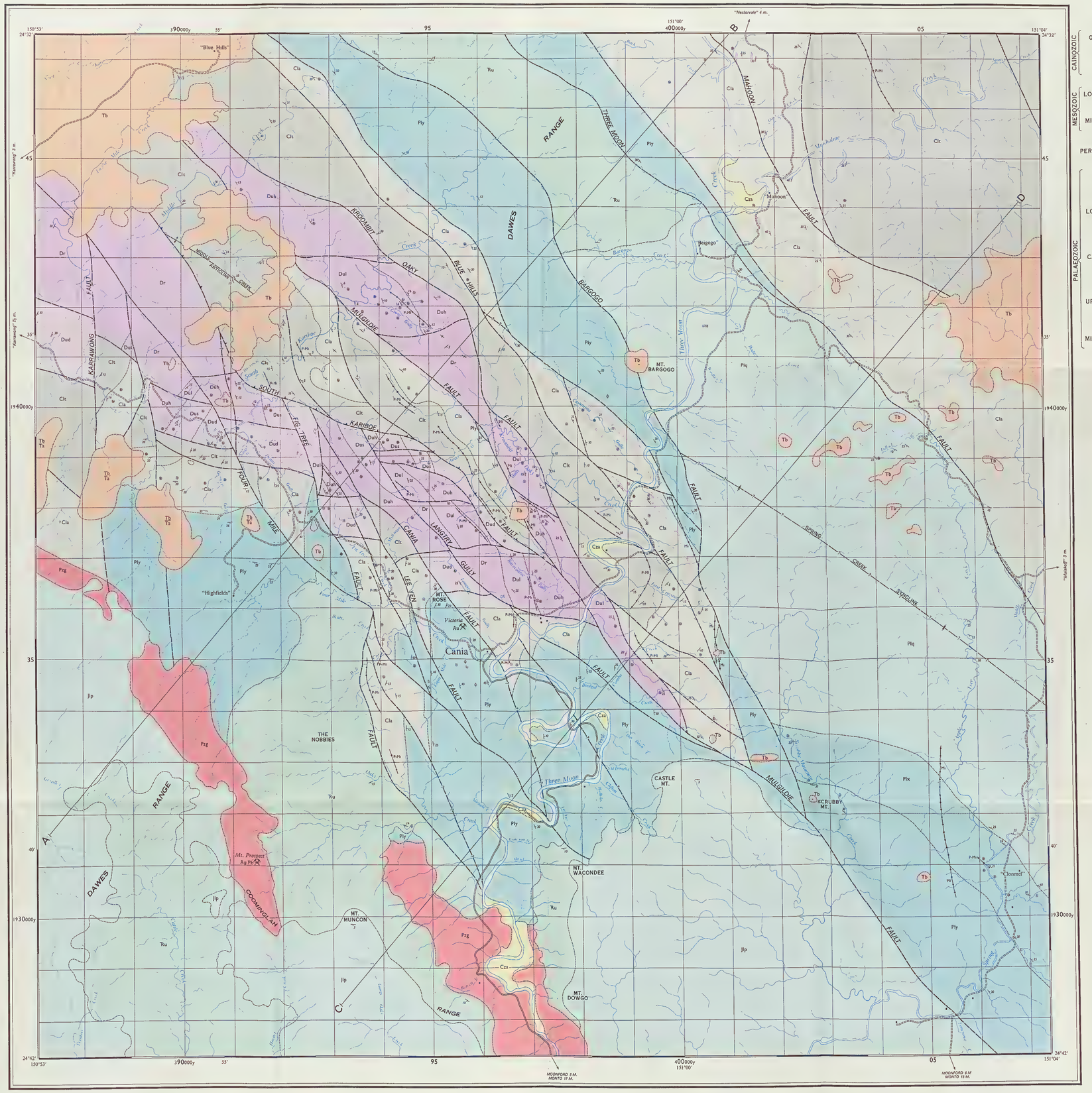
CANIA
SPECIAL

GEOLOGICAL SURVEY OF QUEENSLAND PUBLICATION NO. 330

1:31,680 SPECIAL

SECTIONS
Natural Scale





Reference

CAINOZOIC	QUATERNARY	Cza	Alluvium
	TERTIARY	Tb	Olivine basalt
		Ta	Mudstone, quartz sandstone
MESOZOIC	LOWER JURASSIC — Precipice Sandstone	Jlp	Quartz sandstone, siltstone, conglomerate
	LOWER OR MIDDLE TRIASSIC — Muncon Volcanics	Ru	Basic lava, tuff, agglomerate, siltstone
		Pf	Felspar porphyry dyke
	PERMIAN OR TRIASSIC	P-Mi	Dolerite, diorite, felspar porphyry dyke or sill
PALAEOZOIC	PERMIAN	Pzg	Granodiorite, granite, adamellite
	LOWER PERMIAN — Owl Gully Volcanics	Plq	Basic lava, tuff, agglomerate, siltstone, lithic sandstone
	LOWER PERMIAN — Yarrol Formation	Plx	Siltstone, mudstone, lithic sandstone, coquinoid limestone
	LOWER PERMIAN — Youlambie Conglomerate	Ply	Conglomerate, pebbly mudstone, lithic sandstone, mudstone, acid tuff
	LOWER CARBONIFEROUS — Cania Formation	Cla	Lithic sandstone, mudstone, siltstone conglomerate, acid and basic lava, oolitic limestone
	LOWER CARBONIFEROUS — Three Moon Conglomerate	Clt	Conglomerate, basic lava, tuff, agglomerate, siltstone, mudstone
	UPPER DEVONIAN — Dawes Range Formation, Denny Gully Member	Dud	Basic lava, tuff, agglomerate, conglomerate, lithic sandstone, siltstone, mudstone
	UPPER DEVONIAN — South Kariboe Member	Dus	Lithic sandstone, conglomerate, siltstone
	UPPER DEVONIAN — Milkman Creek Member	Duh	Mudstone, siltstone, lithic sandstone, conglomerate, basic lava, tuff
	UPPER DEVONIAN — Langtry Gully Member	Dul	Lithic sandstone, conglomerate, siltstone, chert, basic lava, tuff
	MIDDLE TO UPPER DEVONIAN — Kroombit Beds	Dr	Basic lava, tuff, agglomerate

Geological boundary
Syncline, anticline
Fault
Where location of boundaries folds and faults is approximate, line is broken; where inferred, queried
Thrust fault (▲ indicates upper plate)
Strike and dip of strata
Vertical strata
Marine fossil
Plant fossil
Oolitic limestone
Au Ag Pb — Gold, silver, lead
Victoria — Mine (abandoned)
Road
Vehicle track
"Mahoon" — Homestead
Building, yard
Dam, earth tank
Swamp

KEY TO 1:250,000 SERIES

SCALE 1:31,680

CHAINS 40 0 40 80 120 160

YARDS 0 1000 2000 3000 4000

Geological mapping by J. F. Dear, Ph.D., 1959-1964 from detailed ground traverses and photo interpretation. Compiled from 1958 aerial photographs- scale 1:25,000. Transverse Mercator Projection. 1000 yard grid. Drawn by T. M. Lisle, Drafting Section, Department of Mines, Brisbane. Printed at the Government Printing Office.

CANIA
SPECIAL

Copies of this map may be purchased from the Geological Survey of Queensland, Edward St., Brisbane

622.009
Qu 31.

QUEENSLAND
DEPARTMENT OF DEVELOPMENT AND MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 331

THE GEOLOGY OF THE CANNINDAH CREEK AREA, MONTO DISTRICT, QUEENSLAND

by
R. G. McKELLAR, M.Sc.

BRISBANE
By Authority: S. G. REID, Government Printer
1967

2 - FEB 1968

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THE GEOLOGY OF THE CANNINDAH CREEK AREA, MONTO DISTRICT, QUEENSLAND

R. G. McKellar, M.Sc.

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

The paper deals with the stratigraphy, sedimentation, biostratigraphy and structure of the Carboniferous rocks in an area about Cannindah Creek, near Monto in south-eastern Queensland. This area takes in the central part of the Yarrol Syncline or Trough on the eastern side of the Yarrol (Structural) Basin. The Carboniferous succession is more than 15,000 feet thick. It is divided into a lower unit of unknown thickness, the Crana Beds, and seven formations: Bancroft Fm., Splinter Creek Fm., Dakiel Fm., Baywulla Fm., Branch Creek Fm., Poperima Fm. and Rands Fm. Named members are the Herring Gully Limestone (Bancroft Fm.), the Kolonga Creek Limestone (Splinter Creek Fm.), and the New Cannindah Conglomerate (Dakiel Fm.). Two groups separated by a disconformity are recognized. The Caswell Creek Group of Lower Carboniferous age includes the first four formations listed above; the Boiling Creek Group of Upper Carboniferous age, the last three listed. The Triassic Muncon Volcanics and the Tertiary basalts and sediments that unconformably overlie the Palaeozoic strata are briefly noted. Carboniferous sedimentation is discussed in terms of provenance, transportation, depositional environment, lithification, basin shape, and overall controlling influences. The main findings are as follows: (1) The predominant sources of sediment were acidic and intermediate lavas and tuffs; granite supplied some material in the Upper Carboniferous. (2) Sediment was transported for relatively limited distances and deposited by normal marine currents on a shelf which sloped to the east over the entire period. (3) Arenites and rudites in the succession are tightly cemented and lack potential as subsurface reservoirs. The relative abundance of acidic and intermediate volcanic rock fragments in them determines the cementing minerals deposited: those with much acidic material have chalcedonic silica and calcite cements; those with intermediate material have chlorite, zeolite and calcite cements. (4) Shorelines in the basin had nearly meridional trends throughout the Carboniferous and their successive positions, based on the geographic distribution of faunas, indicate post-Tournaisian regression to the east, with complete withdrawal of the sea by the Namurian. Transgression over the eastern margin of the structural basin occurred again in the Upper Carboniferous (Westphalian). (5) There is no evidence for an eastern shoreline to the sedimentary basin. (6) Eustatism may have caused the broadly cyclic pattern of sedimentation in the Lower Carboniferous, the regression and the transgression. In the section on biostratigraphy, fossils are organized into a system of nine *faunas*. Each comprises allied fossils from one or more horizons, and its age and diagnostic species are indicated. The *faunas* are used as a basis for the correlation of the Cannindah Creek section with the Carboniferous rocks elsewhere in Queensland and New South Wales.

The principal structural elements in the Yarrol (Structural) Basin about Monto are the Mulgildie Fault at the western margin, the Tellebang Anticline, the Yarrol Syncline, and the Yarrol Fault at the eastern margin. In the map area, the Yarrol Syncline is dislocated by a major ?low-angle thrust, the Tiverton Fault, and its limbs fractured by large normal (strike) faults, of which the Kalpowar Fault is the greatest, and less frequent high-angle reverse faults. The structural pattern has resulted from three phases of mobility. (1) Upper Permian folding, reverse and low-angle thrust faulting, and granite emplacement. (2) Upper Triassic normal faulting with associated saxonic folding and dyke intrusion. (3) ?Upper Cretaceous normal faulting restricted to the Mulgildie Fault.

INTRODUCTION

The present mapping project was undertaken with the objective of establishing the Carboniferous stratigraphy along the eastern side of the Yarrol Basin for use on the Monto 1:250,000 geological sheet, and to provide a basis for the systematic description of the numerous fossil marine faunas. The Cannindah Creek area was selected as the most suitable for this purpose, as the writer's regional mapping on the above sheet had shown it to have the most complete Carboniferous succession preserved in this southern part of the basin. In addition, a considerable amount of detailed mapping and collection of faunas had been done already in the district as part of a post-graduate study in the Department of Geology and Mineralogy, University of Queensland (McKellar, 1961 MS).

The mapped area is 65–70 square miles, and includes the central part of the Yarrol Syncline, or Trough, between latitude 24°45′S. and latitude 24°52′S., and longitude 151°13′E. and longitude 151°21′E. Monto is the nearest sizeable town and lies to the west a little over six miles from the south-western corner of this quadrangle. Other points of reference are the small township and railway siding

of Bancroft, just inside the western boundary, and the siding of Dakiel near the northern boundary. Splinter Creek and its large eastern tributaries Cannindah Creek and Branch Creek drain the area, and the former enters the Burnett River about twenty miles to the south.

Complete aerial photographic coverage of the area is provided by Adastra: Monto 1:25,000 (1958), and Monto 1:85,000 (1961) photographs. The topographic base map was prepared from the Monto 1:25,000 photographs, and redrafted at a scale of half-a-mile to the inch. Partial control was achieved by adjustment, where necessary, to the surveyed roads that are shown on the Lands Department 40-chain parish maps. In addition, the map was checked for distortion against an enlargement of a 1:85,000 base map with planimetric control, that had been used in compilation of the Monto 1:250,000 geological sheet. The Monto 4-mile military sheet, the 2-mile lands map (No. 158), and the 40-chain lands maps (Parishes of Cannindah and New Cannindah, County of Yarrol) had insufficient topographic detail for use as a base map; however, the latter are particularly useful for the citation of locality references.

Previous published work on the map area includes a brief list of fossil corals, brachiopods and molluscs from Splinter Creek one mile south of Bancroft, by Whitehouse (1927), and the author's descriptions of a brachiopod fauna from the Branch Creek Formation (McKellar, 1965), and a blastoid from the Dakiel Formation (McKellar, 1964). The literature on the Yarrol Basin in the Monto district at large is more complete. Reid (1927) gave a short description of the Lower Carboniferous section to the east of Monto between Old Cannindah and New Cannindah homesteads. He recognized the anticline later designated the Tellebang Anticline by Maxwell (1960a), and on his map indicated the thick "Cannindah Limestones" trending to the north-west from Old Cannindah homestead. Later, Reid (1930, p. 32) gave an additional note on the Carboniferous section on Major Mitchell Creek, immediately to the south of the Mt. Cannindah Mineral Field near Kalpowar. His section appears to have extended from the upper part of the Lower Carboniferous succession into the earliest beds of the Upper Carboniferous. The Carboniferous and Permian stratigraphy and marine faunas of the Yarrol region, several miles to the south of Cannindah Creek, were briefly described by Maxwell (1959, 1960a and b, 1964), and the Lower Carboniferous shelly faunas about Old Cannindah station by Maxwell (1961a and b). A few corals from the Cannindah Limestone about Old Cannindah were listed by Whitehouse (1927) and Hill (1934). Other corals from the limestone were figured by Hill and Woods (1964), and corallum increase in the species of *Lithostrotion* was described by Jull (1965a). The limestones of the area are the only workable mineral deposits known, and were listed by Connah (1958, p. 11) in his assessment of the limestone resources of Queensland; to date they have attracted little commercial attention.

In this paper, sections have been written on the stratigraphy, the broader aspects of Carboniferous sedimentation, biostratigraphy, and local and regional structure. The stratigraphy is intended to complement a parallel study by Dr. J. F. Dear, which will document the Upper Devonian and early Carboniferous strata and faunal succession about Cania, twenty miles north-west of Monto.

Acknowledgements

The writer wishes to thank Professor D. Hill, Professor A. F. Wilson, and Dr. W. G. H. Maxwell of the Department of Geology and Mineralogy, University of Queensland, for their assistance in the preliminary work on this subject, and for later access to the palaeontological collections of the department; Mr. A. K. Denmead, Chief Government Geologist at the Geological Survey of Queensland, for permission to undertake the project, his encouragement and editorial assistance; Messrs. G. W. Tweedale, P. J. G. Fleming, and Mr. R. M. Tucker, all of the Geological Survey, for editing the manuscript; Messrs. J. Wright and G. Lihou of the Mines Department, for the drafting of the accompanying map and text-figures respectively.

STRATIGRAPHY

The succession of marine strata in the Cannindah Creek area is extremely thick, and well in excess of 15,000 feet of (?) late Devonian and Carboniferous sediments outcrop between the axes of the Tellebang Anticline and the Yarrol Syncline. The sequence is divided into a lower incompletely known unit, the Crana Beds, and seven formations: Bancroft Fm., Splinter Creek Fm., Dakiel Fm., Baywulla Fm., Branch Creek Fm., Poperima Fm. and Rands Fm. Of these, the last four were named by Maxwell (1959, 1960a) from the Yarrol structural block approximately ten miles to the south of the map area. Extensive cappings of lateritized Tertiary sediments obscure most of the Palaeozoic sequence between the two areas.

In the Yarrol block, strata beneath the Baywulla Formation were designated the Black Mountain Formation by Maxwell (1959, p. 29), with type section in the main creek "flowing" due east from Black Mountain into the Burnett River. The name was unavailable because of prior use, and the formation was renamed the Tellebang Fm. (Maxwell, 1960a, p. 168). The type section was examined by the author and Mr. R. M. Tucker of the Geological Survey as a preliminary to mapping the Monto 1:250,000 sheet, and found to be extensively faulted. A lower unit of green subgraywacke, granule and pebble conglomerate, overlain by mudstone with *Leptophloeum australe* (McCoy) occurs on the western side of the fault, or faults. East of the fault, a sequence of mudstone and minor dark subgraywacke and detrital limestone has a Viséan marine fauna of *Eomarginifera paradoxa* (Campbell), *Unispirifer* cf. *striatoconvolutus* (Benson and Dun), and *Balanoconcha elliptica* Campbell. Thus, strata between the lower part of the Crana Beds and the upper part of the Dakiel Forma-

tion of the Cannindah Creek area, are missing from the type section of the Tellebang Formation. In this circumstance, the formation must be regarded as invalidly conceived and it is suggested that use of the name should cease for the present time. The name "Tellebang Formation" should be re-employed in a restricted sense when the Crana Beds are finally subdivided into formations. Such a subdivision can be expected as the beds comprise two distinct units: the lower mainly of green subgraywacke and conglomerate, the upper mainly of brown mudstone.

The lower unit is typified by the coarse grained green sediments that outcrop to the west of the fault in the type section of the Tellebang Formation, as originally defined. In addition, the name is particularly appropriate as some of the finest exposures of these strata occur in Tellebang Creek where it flows across the axial zone of the Tellebang Anticline.

Two groups of formations are recognized: the Caswell Creek Group includes the Bancroft, Splinter Creek, Dakiel, and Baywulla Formations; the Boiling Creek Group includes the Branch Creek, Poperima, and Rands Formations. They are defined primarily for use on the Monto 1:250,000 geological sheet. The folded Upper Palaeozoic strata are overlain unconformably by Triassic lavas and tuffs, the Muncon Volcanics of Dear (1967), and these in turn by Tertiary sediments and basalt flows.

The repositories for the rock specimens cited in this section are the Geological Survey of Queensland (G.S.Q.) and the University of Queensalnd (U.Q.). Fossil locality numbers mentioned in text and indicated on the map of the Cannindah Creek area are prefixed by K or L. These numbers refer to the registers of the Geological Survey and University of Queensland respectively.

CRANA BEDS

The beds comprise a considerable, but undetermined thickness of marine strata lying beneath the Bancroft Formation in the Tellebang Anticline (Maxwell, 1961) in the area to the east of Monto. Their name is derived from Crana railway siding in the north-west corner of Parish Cannindah, County Yarrol. The beds consist of two distinct units: the lower of dark green, lithic conglomerate and coarse subgraywacke, with interbedded andesitic lava and brown mudstone; the upper essentially of brown mudstone and shale, with minor subgraywacke and lutaceous limestone in its upper beds. The lower unit outcrops in the axis of the Tellebang Anticline between Crana and Mungungo, and to the north of this area in the tributaries of Monal Creek. The upper unit has negligible outcrop but is typically exposed in cuttings on the road linking Old Cannindah and Yarrol homesteads, between the axis of the anticline and Ventnor School, and along the track diverging to the east from that road in Portions 132 and 117, Parish of Cannindah. Similar, less complete exposure is seen along the road west from Bancroft to Mungungo. The upper beds occupy a belt of low, rolling country on the western margin of the map area, between the eastern branch of Herring Gully and Bancroft. Equivalents of the Crana Beds occur over much of the Yarrol Basin between Monto and Calliope.

The limestone 1,300 feet below the top of the upper unit is a lenticular development and is known only in the area to the east of Splinter Creek, and south of its tributary Cannindah Creek. Its maximum thickness of approximately 40 feet occurs in road-side outcrop about one mile north of Ventnor School. The limestone is dark grey and composed of a fine semi-opaque calcite mosaic in which occasional brachiopod and bryozoan fragments are scattered. Pyrite forms segregations, and replaces many of the brachiopods in the rock, e.g. R. 4453 U.Q. In the south of the map area thick, green, medium and coarse-grained subgraywache beds outcrop some 350 feet above the limestone. These arenites contain andesitic lava fragments (70–80%), sodic plagioclase (5–15%), and organic (crinoidal) calcite, and are cemented by sparry calcite and chlorite. They weather easily and deeply. Fossiliferous, fine subgraywacke, some of which is very calcareous, is interbedded with mudstone in the uppermost 350 feet of the formation.

Flora and Fauna

(i) Lower part of mudstone sequence; localities K. 14, 22, 23 G.S.Q.
Leptophloeum australe (McCoy)
Indet. equisetalean plant fragments

(ii) Lutaceous limestone, 1,300 feet below top of beds; locality L. 2300 U.Q.

Brachiopoda:
Schizophoria aff. *resupinata* var. *rotundata* Demanet
Leptagonia cf. *analoga* (Phillips)
Schellwienella sp.
Productina globosa Roberts
Unispirifer sp.

Mollusca:
Straparollus cf. *davidi* Dun and Benson

(iii) Uppermost 350 feet of beds; localities K. 90, 91, G.S.Q.; L. 2308 U.Q.

Brachiopoda:
Schizophoria aff. *resupinata* var. *rotundata* Demanet
Schuchertella sp.
Rugosochonetes kennedyensis Maxwell
Avonia (?) aff. *kennedyensis* Maxwell
Ovatia sp.
Prospira cf. *typa* Maxwell
Adolfia (?) *kennedyensis* Maxwell
Cleiothyridina cf. *segmentata* Roberts
Camarotoechia sp.

Mollusca:
Bellerophon microstriatus (Maxwell)
Orthonychia sp.
Straparollus cf. *davidi* Dun and Benson
Porcellia cf. *pearsi* Etheridge fil.
Aviculopecten (?) sp.
Edmondia sp.

Age and Stratigraphic Relationships

In the Star Basin, North Queensland, *Leptophloeum australe* (McCoy) occurs in association with marine faunas of definite Famennian and lower Tournaisian age. A similar range might be expected in the Yarrol Basin. Brachiopod and molluscan faunas from the upper part of the beds are regarded as upper Tournaisian in age. Facies equivalents of the Crana Beds in the Cania area, north-west of Monto, possibly include part of the Famennian Dawes Range Formation, and certainly the Tournaisian Three Moon Conglomerate, and lower part of the Cania Formation (below the"*Martinia productoides* Limestone"). These presumably near-shore strata have marine fossils at numerous horizons. Thus, the greater part of the Crana Beds was probably deposited in the early Carboniferous, but some of the oldest beds outcropping in the core of the Tellebang Anticline could be late Devonian in age. The unit is conformably overlain by the Bancroft Formation.

CASWELL CREEK GROUP

The group comprises the Bancroft, Splinter Creek, Dakiel and Baywulla Formations, and has a thickness of approximately 9,000 feet in the Cannindah Creek area. Its name is derived from Caswell Creek in Parish New Cannindah, County Yarrol. The sequence is characterized by repeated oolitic limestone development that is without parallel in older or younger Palaeozoic, and Mesozoic strata in Queensland. As such, it is regarded as a litho-genetic entity. A part of the fossiliferous Middle Devonian (Givetian) limestone at Kroombit to the east of Biloela is oolitic, but this occurrence is relatively limited. The other rock types are mudstone, subgraywacke and conglomerate with abundant acidic and intermediate lava and tuff fragments, and detrital and lutaceous limestone. The group was deposited in the Lower Carboniferous in the time interval from the upper Tournaisian to the upper Viséan. It approximates to the present conception of the Rockhampton Group (originally "Series") in the Rockhampton area, which, as defined by Fleming (1967), extends from the Gudman Oolite ("*Michelinia* Limestone" of Hill, 1943) to the top of the Lion Creek Limestone. The Gudman Oolite is believed to be a northern equivalent of the Herring Gully Limestone Member at the base of the Bancroft Formation, but firm correlation of the Lion Creek Limestone with one of the limestones in the Cannindah Creek succession is not yet possible. It may be equivalent to strata in either the Dakiel or Baywulla Formations.

BANCROFT FORMATION

The name of the formation is derived from the township of Bancroft, Parish Cannindah, County Yarrol—approximately fourteen miles by rail north-east of Monto. The type section is taken to be along and about the boundary fence between Parishes of New Cannindah and Cannindah, from 300 yards east of the Bancroft-Dakiel road to 1,050 yards west of it. The section is on the western limb of the Yarrol Syncline. The lithologies in order of importance are: brown mudstone, grey and light brown, very feldspathic and calcareous subgraywacke, oolitic and lutaceous limestone, and in very small amounts, pebble and granule conglomerate. Thickness is approximately 3,000 feet in the type section and remains fairly uniform over the map area.

In the map area, the unit is easily recognized from Herring Gully in the south, to the Crana-Dakiel road in the north. The main road from Monto to Gladstone crosses the formation between 0·5 and 1·3 miles from Bancroft, but it is not well exposed. The formation has a rather subdued topography developed on it, although a moderately strong strike ridge marks the position of the subgraywacke-conglomerate unit (fig. 1, unit C) 800 feet above the base.

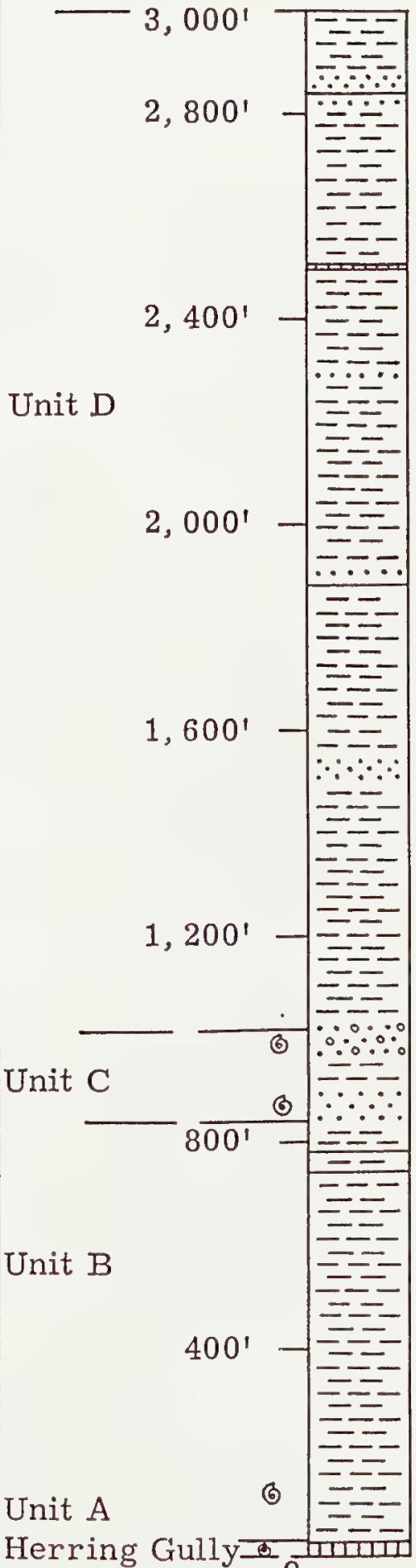
Stratigraphic Succession

For ease of discussion, this and subsequent formations have been subdivided into a sequence of informal units labelled by letter symbols (A, B, C etc.); these are indicated on the appropriate stratigraphic columns.

Brown mudstone and shale are the prevalent lithologies (fig. 1). The base of the formation is delineated by thick oolitic limestones which are named the **Herring Gully Limestone Member.** The member comprises two limestone beds with an intervening calcareous shale bed about six feet thick. It is 20–25 feet thick in the type section of the formation, which is also taken as its type section. The limestones are unusually thick (300 feet) in the north-east part of Portion 25, Parish Cannindah; repetition by faulting may be responsible, but no such structures are evident. Further south the member outcrops well in Portion 81, Parish Cannindah on the main north-east tributary of Herring Gully—hence its name. The limestones are grey, variably oolitic or detrital, and relatively free of terrigenous sand grains. They are usually well bedded, without marked cross-stratification. Oolites are moderately large (1·5–1·8 mm.) and generally constitute 50–70% of the rock; their concentric structure is well preserved except where local strong deformation seems to have accelerated recrystallization. Most oolites have calcite nuclei (echinoderm, brachiopod and algal fragments), but some have nuclei of quartz, sericitized feldspar or acidic lava fragments. Calcite grains of organic origin are normally present to the extent of about 20–25%, but in certain beds the limestone has an abundance of them, e.g. R4454 U.Q. has 60% echinodermal material, 5% brachiopod fragments, and 2–3% each of foraminifera and *Girvanella*-like algae. A recrystallized sparry calcite matrix is usually present. Quantities of mud clasts occur at the base of the member in some areas.

TYPE SECTION OF BANCROFT FORMATION

Measured along fence between Parishes Cannindah and New Cannindah, County Yarrol, between 1,050 yards west, and 300 yards east of Bancroft-Dakiel road.



grey, sandy oolitic limestone; m., v. calc. subgr. with much felds., some qtz., calcite matrix.

dark, oolitic and detrital limestone

light brown mudstone

v. calc., felds. subgr.

light brown, c. & pebbly, v. calc., felds. subgr.; cgt.

grey, m. & c., felds., calc. subgr.

brown mudstone, calc. in part.

well bedded, grey, oolitic limestone; brown calc. mudstone.

GRAIN SIZE

f - fine	0·06-0·25	mm.
m - medium	0·25-1·0	mm.
c - coarse	1·0 -2·0	mm.

Fig. 1

The mudstone and shale of unit B are seen only in road cuttings, but thin oolitic and detrital limestones occur about the middle of the interval near New Cannindah School. Two thick, essentially subgraywacke intervals, separated by 30 to 50 feet of mudstone, form the distinctive unit C at approximately 800 feet above the base of the formation. The subgraywacke intervals have some interbedded mudstone throughout their thickness, but this appears to be fairly minor. The unit is nearly 200 feet thick. The lower outcropping beds are dark grey, medium and coarse-grained, very calcareous subgraywacke which weathers easily; the upper outcropping beds are light brown, coarse, pebbly subgraywacke with thin beds of granule and pebble conglomerate. Both beds are characteristically feldspathic, and sodic plagioclase (15–20%) is sericitized and slightly rounded; quartz (5%) is without strain and embayed grains occur. The lithic fragments are the most abundant rock components (30–40%). Dacite and other fine siliceous lava grains are much more abundant than andesite fragments, and this contributes to the relatively light colour of the rock. These fragments are well rounded. All rocks in the unit are very calcareous (20%), with subequal quantities of dark oolites and organic calcite grains (echinoderm and brachiopod detritus). Silica is the primary cement; calcite fills the remaining interstices.

In the upper two-thirds of the formation (unit D) limestone and calcareous subgraywacke beds are thin with the exception of some large lenses of calcilutite and the uppermost calcareous subgraywacke. The thin subgraywacke beds are often pebbly and invariably very calcareous; feldspar content is high. The limestones are dark, with small oolites and an abundance of matrix that has been recrystallized to sparry calcite. Nuclei of the oolites are usually intermediate lava grains. A very large calcilutite development occurs in unit D about one mile north-east of the confluence of Splinter Creek and Cannindah Creek (Portion 26, Parish Cannindah). In this area the limestone appears to be approximately 300 feet thick, but the deposit is lenticular and about a mile to the north-west outcrop is lost. A smaller development occurs about four miles further north in the western part of Portion 2, Parish New Cannindah. The limestone is light grey and over much of its thickness very pure; intergradation with calcareous mudstone occurs in places. The uppermost arenaceous bed in the formation is moderately thick (30 feet) and is characterized by an alternation of sandy oolitic limestone and light grey, medium-grained calcareous subgraywacke. These rocks have extremely small dark oolites (20–50%), a moderately high quartz content (10%), and abundant sodic plagioclase (30%); lava content is low (5%). A recrystallized sparry calcite matrix is invariably present.

Fauna

Fossils occur sporadically throughout the formation, but good collections were obtained from only two main horizons.

(i) Herring Gully Limestone Member; localities L. 2301, 2452 U.Q.; K. 98, 99 G.S.Q.

Brachiopoda:

Schizophoria aff. *resupinata* (Martin)
Rhipidomella australis (McCoy)
Leptagonia cf. *analoga* (Phillips)
Schellwienella sp.
Marginatia (?) sp.
Rugosochonetes kennedyensis var. *magnus* Maxwell
Delepinea sp.
Unispirifer aff. *striatoconvolutus* (Benson and Dun)
Prospira prima Maxwell
Syringothyris sp.
Brachythyris aff. *solida* Campbell
Martinia productoides Etheridge fil.
Brachythyris elliptica Roberts
Cleiothyridina sp. indet.

Mollusca:

Euomphalus (?) sp.

(ii) Arenites of unit C; localities K. 83, 84, 89, 92 G.S.Q.; L. 2321 U.Q.

Bryozoa:

Fenestella sp.

Brachiopoda:

Rhipidomella australis (McCoy)
Leptagonia cf. *analoga* Phillips
Schellwienella sp.
Productina (?) sp. indet.
Dictyoclostus sp.
Rugosochonetes sp.
R. kennedyensis var. *magnus* Maxwell
Spirifer sp.
Prospira typa var. *tellebangensis* Maxwell
P. cf. *prima* Maxwell
Unispirifer aff. *striatoconvolutus* (Benson and Dun)
Syringothyris sp. indet.
Mucrospirifer (?) sp.
Kitakamithyris cf. *uniplicata* (Campbell)
Brachythyris cf. *elliptica* Roberts
Adolfia (?) sp.
Cleiothyridina transversa Maxwell

Mollusca:

Baylea sp.
Austroworthenia levis Maxwell
Straparollus australis Maxwell
Loxonema lamellosa Maxwell

Arthropoda:

"*Phillipsia*" sp. indet.

Age and Stratigraphic Relationships

The age of the lower fauna is considered to be upper Tournaisian; that of the upper fauna, late Tournaisian or early Viséan. The formation is succeeded by the Splinter Creek Formation with apparent conformity. Regional equivalents include that part of the Cania Formation above the *"Martinia productoides* Limestone" in the Cania area (Dear, 1967), and the "Tellebang Formation" east of Splinter Creek on Old Cannindah station near Monto (Maxwell, 1961a). The sequence at Cania is predominantly arenaceous, and represents a near shore facies.

SPLINTER CREEK FORMATION

The formation name is derived from Splinter Creek, the major tributary of the Burnett River in the map area. It cuts across the formation approximately two miles east of Bancroft, Parish Cannindah, County Yarrol. Structural complications in the map area prevent selection of a single, complete type section, so that it seems desirable to define two partial type sections with a very prominent limestone, which is designated the **Kolonga Creek Limestone Member,** the unit held in common. The section regarded as typical of the lower part of the formation, and which includes the type section of the Kolonga Creek Limestone, occurs in Portion 12, Parish New Cannindah. It extends west along the road from Crana to Dakiel for approximately 400 yards from the intersection with the Pine Mountain road. The member is named from Kolonga Creek which flows across it less than half-a-mile north of its type section. Type section for the upper part of the formation occurs along the north bank of Cannindah Creek in Portions 27 and 72, Parish Cannindah, and extends west 600 yards from the gully entering Cannindah Creek near the western boundary of Portion 72. Lithologies in the Splinter Creek Formation are brown mudstone, dark green and red-brown, very calcareous subgraywacke and polymictic conglomerate, oolitic, detrital and lutaceous limestone. The formation is approximately 2,600 feet thick; the stratigraphically lower partial type section contributes 720 feet, the upper partial section 1,980–2,000 feet.

In the area under discussion the Splinter Creek Formation is well exposed along the western limb of the Yarrol Syncline from the Pine Mountain road near the northern partial type section, to the area 1·5 miles south of Cannindah Creek where it is truncated by the Tiverton Fault. On the eastern limb, fine-grained sediments lying below the Dakiel Formation, and presumed to represent a deeper-water facies of this formation, outcrop in a limited area along Cannindah Creek in Portions 76 and 77, Parish of Cannindah. In its typical development, the formation produces rather subdued topography, only a little more elevated than that over the Bancroft Formation. Units with much arenaceous sediment occur in the lower and middle portions of the formation and these form broad rounded strike ridges. Thick mudstone units above the Kolonga Creek Limestone and at the top of the formation are represented by valleys in which strata outcrop only in the low stream divides.

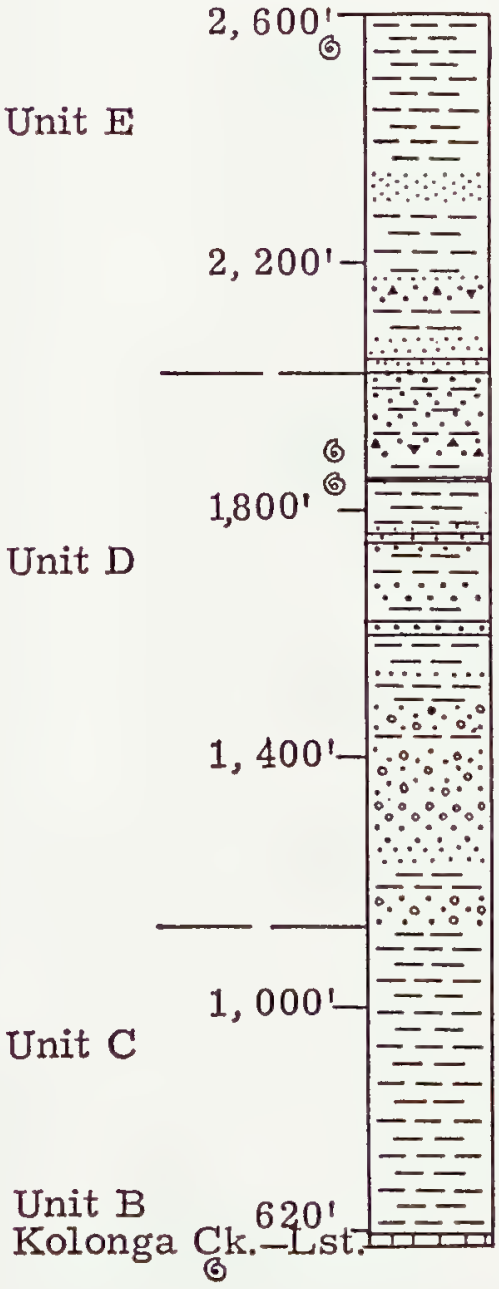
Stratigraphic Succession

The base is delineated by a polymictic conglomerate bed and this is overlain in unit A (fig. 2) by a sequence of rapidly alternating, thin mudstone, calcareous subgraywacke and limestone beds. The conglomerate is approximately fifteen feet thick in the type section, but in the area 2–3 miles further south it is largely replaced by pebbly subgraywacke; maximum development seems to be in the northern part of Portion 26, Parish Cannindah, where it approaches 25 feet in thickness. The rock is tough and dark grey-green in colour. Pebbles are rounded and typically less than one inch in diameter; in areas where the bed is thick, boulders of eight inches diameter have been observed. Those pebbles examined in the field were predominantly intermediate lava fragments, but many appeared finely siliceous and probably represented acidic lava or devitrified tuff fragments. Most subgraywacke beds in unit A are coarse-grained, grading to granule conglomerate, and are dark green in colour. Lithic fragments (70%) comprise andesitic material (40%), and varying quantities of trachyte and dacite-like acidic lava, e.g. G.S.Q. 4008, R14523 U.Q.; subangular plagioclase feldspar (5–10%) is a relatively minor constituent; quartz content is insignificant. These rocks are invariably calcareous with 1–2% oolites, and up to 10% organic calcite, usually crinoid fragments. Grain interstices are filled by chlorite, epidote, zeolite and calcite. Unit A has six limestone beds (dark spergenite and arenaceous spergenite) in the type section; most are thin (6 ins.–2 ft.), and impersistent laterally. The spergenites contain a large proportion of organic detritus, almost wholly crinoidal, up to 30% oolites, and argillaceous material (mud) to the extent of 10%. Arenaceous spergenites have 20–40% green intermediate lava grains of coarse sand or granule grade. Brown, moderately calcareous mudstone in unit A is exposed in road cuts on the Bancroft–Dakiel road between 0·4 and 0·8 miles south of the intersection with the Pine Mountain road.

The Kolonga Creek Limestone Member is approximately 120 feet thick in its type section, and has four limestone beds with intervening mudstone. The lowest limestone (15–20 feet) is mid-grey, relatively pure and oolitic; it is well bedded and at times partly cross-stratified. Oolites (50%) of 1 mm. diameter lie in a calcite matrix; little organic calcite is present, but some intermediate lava grains (2–5%) always occur. The main limestone, 25–30 feet thick and 40 feet above the lowest limestone, varies from arenaceous spergenite at its base, through crinoid-rich spergenite and oolite beds. The upper limestones are arenaceous spergenite (3 feet) and micro-coquinite (6–7 feet) respectively. The member has greatest development one mile north along strike from its type section, where bank type growth of compound and solitary rugose corals occur in lutaceous and partly oolitic limestones. Half-a-mile south of the type section the lower oolite is overlain by mudstone, coarse green subgraywacke and granule conglomerate, and an upper limestone conglomerate (30–40 feet). The latter is composed of pebbles and cobbles of limestone up to four inches in diameter,

TYPE SECTION OF SPLINTER CREEK FORMATION

Upper section measured along north bank of Cannindah Creek in Portions 27 and 72, Parish Cannindah, County Yarrol.



brown moderately calc. mudst.; black argillaceous lst.; f. subgr.

red-brown, c., v. calc. subgr.; brown mudst.; mudst. cgt.; dark micro-coquina.

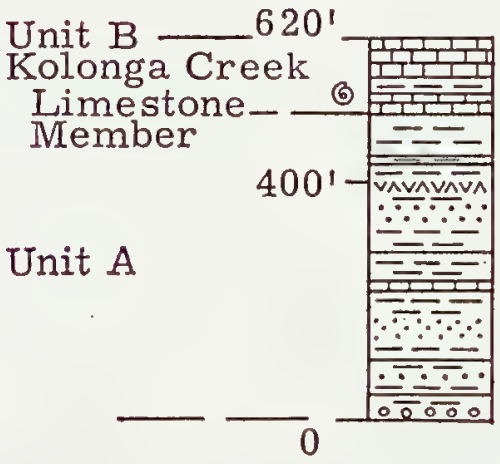
dark grey-brown calc. mudst.; dark green, c., calc. subgr.; oolitic and detrital lst.

dark green and red-brown calc. subgr., cross-bedded in part; pebbly subgr. & polymictic pebble cgt.

brown mudstone

grey lutaceous limestone

Lower section measured along Crana-Dakiel road, west 400 yards from intersection with Pine Mountain road; Portion 12, Parish New Cannindah, County Yarrol.



grey, pure oolitic lst., cross-bedded in part; lutaceous lst.; spergenite, aren. spergenite; brown mudst.

brown-green mudst., partly calc.; dark green calc. lithic subg., with chlorite, epidote and calcite cements; spergenite, aren. spergenite.

dark grey-green or red-brown polymictic pebble cgt.; pebbles of intermediate, some acidic lava.

GRAIN SIZES AS FIG. 1.

Fig. 2

together with a small proportion of green and red-brown intermediate lava pebbles. South of Splinter Creek the member has two limestone beds, the lower lutaceous and partly oolitic, the upper quite arenaceous. In the southern partial type section the member is represented by a grey pure calcilutite. Corals are rare in this area.

In the upper part of the formation, above the Kolonga Creek Limestone, mudstone is the predominant lithology. Most outcropping rocks are the arenites and rudites of unit D, but facies variation is such that these are really well developed only in the southern part of the map area. A thick (350 feet) sequence of red-brown and dark green, coarse and pebbly subgraywacke, polymictic conglomerate and minor brown mudstone occurs in the lower part of unit D. In the subgraywackes, abundant intermediate lava fragments (60–70%) are associated with smaller quantities of finely siliceous acidic lava grains (10%); slightly rounded sodic-plagioclase (5%), organic calcite and oolites are minor constituents, e.g. R4456 U.Q. Interstices are filled by chlorite and some calcite. Stratigraphically above these coarse-grained rocks are mudstones with thin beds of green and reddish, very calcareous subgraywacke, and detrital and oolitic limestones. To the east of Bancroft, the uppermost of these, essentially a spergenite, has moderate thickness (6 ft.), and in the south-eastern part of Portion 36, Parish Cannindah, a small bioherm composed largely of *Lithostrotion* species is developed in the bed. In the upper part of unit D, a mudstone conglomerate, which is fairly persistent about the type section, is overlain by an alternation of mudstone and coarse-grained, reddish-brown, very calcareous subgraywacke beds. The mudstone conglomerate (8–10 ft.) has large, elongate mudstone clasts lying roughly parallel to the bedding plane in a matrix of mud, oolites and echinoderm, gastropod and coral fragments. Slumping, or even contemporaneous erosion of a preceding mudstone bed may have been responsible for its formation. In the subgraywacke beds, organic calcite and oolites comprise 15–40% of the rock; among the lithic grains (40–50%), acidic and intermediate lava fragments are present in subequal quantities, e.g. R4457 U.Q. North of Splinter Creek, rocks in the upper part of unit D are more calcareous and subgraywacke beds much reduced. Thin muddy, detrital limestones with abundant echinodermal, molluscan, bryozoan, coelenterate, foraminiferal and algal detritus are present R14528 U.Q.

The uppermost mudstone unit E has thin, fine sand interbeds, and in Portion 2, Parish New Cannindah a sequence of muddy limestones and very calcareous mudstones 8–10 feet thick is present in the upper part. These rocks have detritial organic calcite (30%), together with 5–15% fine terrigenous grains (acidic lava fragments) in a dark matrix of mud and fine calcite.

Fauna

(i) Kolonga Creek Limestone; localities K. 27 G.S.Q.; L. 2384, 3019 U.Q.

Coelenterata:

Aulina aff. *simplex* Hill
Amygdalophyllum cf. *etheridgei* Dun and Benson
A. cf. *inopinatum* Etheridge fil.
A. cf. *conicum* Hill
Amygdalophyllum sp.
Aphrophyllum foliaceum Hill
(?) *A. hallense* Smith
Symplectophyllum mutatum Hill
"Carcinophyllum" cf. *patellum* Hill
Lithostrotion aff. *stanvellense* Etheridge fil.
Syringopora syrinx Etheridge fil.
Vaughanites (?) sp.

(ii) Limestone and mudstone of unit D; localities L. 2383, 2390, 2398 U.Q.

Coelenterata:

Amygdalophyllum cf. *conicum* Hill
"Carcinophyllum" cf. *patellum* Hill
Lithostrotion cf. *columnare* Etheridge fil.
L. cf. *arundineum* Etheridge fil.
Lithostrotion sp.
Syringopora syrinx Etheridge fil.

Mollusca:

Straparollus subdionysii Maxwell
Bellerophon aff. *microstriatus* (Maxwell)

(iii) Upper limestone and mudstone, unit E; locality L. 2402 U.Q.

Coelenterata:

Amygdalophyllum cf. *conicum* Hill

Bryozoa:

Fenestella sp.

Brachiopoda:

Schizophoria aff. *resupinata* (Martin)
Streptorhynchus sp.
Pustula cf. *abbotti* Campbell
Echinoconchus gradatus Campbell
Eomarginifera paradoxa (Campbell)
Chonetes sp.
Spirifer sp. indet.
Acuminothyris triangularis Roberts
Brachythyris elliptica Roberts
Kitakamithyris sp. indet.
Rotaia (?) sp.

Mollusca:

Loxonema sp.
Straparollus cf. *australis* Maxwell
Baylea sp.

Algae:

"Girvanella" sp.
Indet. dasycladacean alga

Age and Stratigraphic Relationships

The faunas are all quite distinctly of Viséan age. The formation is overlain by massive conglomerates of the basal member of the Dakiel Formation; there seems to be faunal continuity, so that conformity in the succession is very likely. Faunal and lithologic similarities suggest that the Cannindah Limestone at Old Cannindah homestead near Monto is equivalent, in part at least, to the Kolonga Creek Limestone. The Washpool Creek Formation and Riverleigh Limestone to the west of Mundubbera (Driscoll, 1960) may also be largely equivalent to the Splinter Creek Formation and Kolonga Creek Limestone Member respectively. These correlations will be discussed in greater detail in the section entitled "Biostratigraphy".

DAKIEL FORMATION

The formation name was selected as outcrop is excellent in the low hills immediately to the west and south-west of Dakiel siding, approximately twenty miles by rail north-east of Monto. The type section is taken to be 300–400 yards to the north and parallel to Cannindah Creek in Portion 72, Parish Cannindah. It extends east 850–900 yards from the west branch of the main tributary entering Cannindah Creek in Portion 72, to the basal limestone of the overlying Baywulla Formation. The section also includes the type section of a lower conglomerate-subgraywacke unit that has been designated the **New Cannindah Conglomerate Member.** Lithologies include polymictic conglomerate of granule to boulder grades, and grey and light grey-green, very feldspathic subgraywacke in the New Cannindah Conglomerate Member; brown mudstone, dark green and red-brown, very calcareous subgraywacke and granule conglomerate, oolitic and detrital limestone in the upper part of the formation. In the type area, formation thickness is 2,600 feet, but it increases to approximately 3,300 feet near Dakiel, assuming no repetition of strata in the thick upper mudstone unit.

The New Cannindah Conglomerate has a maximum thickness of 600 feet in its type area, but it is considerably reduced to the east of Bancroft, and only 350 feet thick near Dakiel. To the north of the map area near Caswell Creek, Parish of New Cannindah, it is again fully developed and it is from these exposures that the member takes its name.

In the map area, the formation outcrops along the western limb of the Yarrol Syncline from the area about, and just to the west of the Splinter Creek bridge near Dakiel, to one mile south of its type section where it is displaced more than half-a-mile to the west by the Tiverton Fault. It outcrops also on the eastern limb and is well exposed over approximately five miles in the structural block south of the Tiverton Fault, that is, in Portions 76, 78 and 79, Parish Cannindah. Topographic expression on both limbs of the syncline is excellent. A very broad, strongly elevated strike ridge always marks the position of the lower conglomerate member, and in the type area in particular, three other well formed, but lower strike ridges are indicative of the succeeding units in which arenaceous sediments are present in proportions sufficient to render them resistant to erosion. Narrow intervening valleys or gullies are the expression of mudstone units.

Stratigraphic Succession

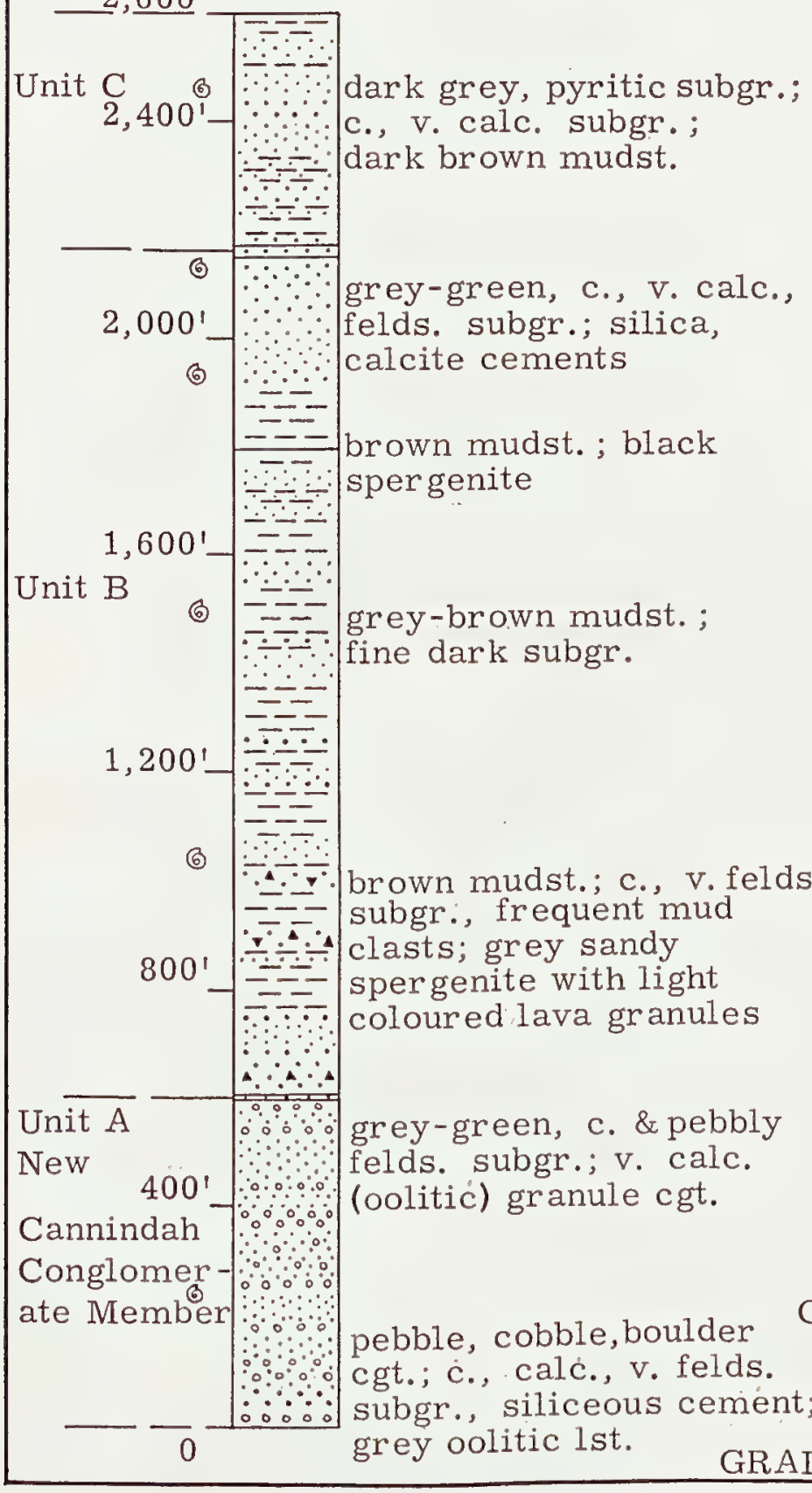
The base of the formation, and the New Cannindah Conglomerate, is defined by a thick (20–30 feet) bed of polymictic conglomerate over most of the area. This bed and the succeeding arenite-rudite succession contrasts markedly with the mudstones of the uppermost Splinter Creek Formation.

Of the conglomerate beds that occur at several horizons in the New Cannindah Conglomerate, those at the base and 350 feet above the base are the largest. The basal conglomerate is massive, poorly bedded and composed of well rounded pebbles, cobbles, and rarely boulders of volcanic rock, mostly acidic lava, but also intermediate lava, rarely vesicular. The conglomerate bed at the top of the member is well bedded in the type area. Its pebbles are small, well rounded, and composed of acidic and intermediate lava fragments in subequal quantities. North of Dakiel, some of the higher conglomerates in the member have large boulders of partly oolitic limestone containing colonies of *Lithostrotion* and solitary *Aphrophyllum foliaceum* Hill in them. Arenites in the member are light coloured (grey and light grey-green) and vary in composition from feldspathic subgraywacke almost to arkose. Lithic grains (30–50%) in these rocks are predominantly acidic lava, but they become more basic toward the top; grains are only moderately rounded, or even subangular. Feldspar (20–50%) too, is quite angular, often subhedral, and is mostly white sodic plagioclase; quartz (10%) is unstrained, often embayed, and angular. All these arenites are quite calcareous and many beds in the upper part of the member grade to sandy oolitic limestone; oolites are usually dark and have nuclei of either calcitic or terrigenous material. Variable quantities of organic calcite, mostly crinoidal, are present in some of the arenites. The primary cement is siliceous and occurs as micro-crystalline films at grain contacts; sparry calcite fills remaining interstices and completely cements the rock. A similar sequence of lithologies occurs on the eastern limb of the syncline where the member has similar or greater thickness. The sediments are as a rule less calcareous, and where oolites are present they occur with smaller detrital grains without carbonate coatings, suggesting an origin elsewhere.

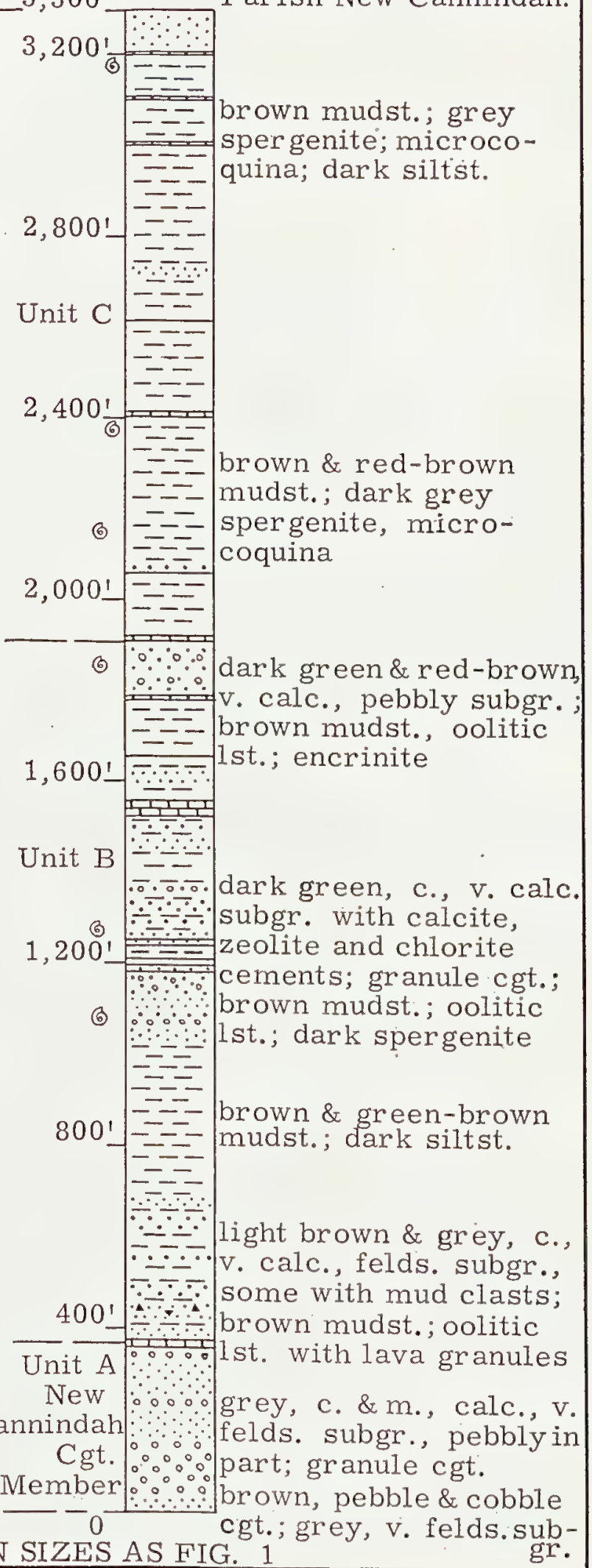
On the western limb of the syncline, brown mudstone is the prevalent lithology in unit B (fig. 3) but the distinctive rocks are the major arenaceous beds. They occur in the unit near the base and top, and in the north about Dakiel, also in the mid-portion. Facies changes from south to north are very considerable in the middle and upper parts of the unit, but the lowest beds maintain their character over the length of the map area and beyond. Sandy and pebbly spergenite

TYPE SECTION OF DAKIEL FORMATION

Measured section 300 yards to north, and parallel to Cannindah Creek; Portion 72, Parish Cannindah, County Yarrol


2,600'
Unit C
2,400'
dark grey, pyritic subgr.; c., v. calc. subgr.; dark brown mudst.
2,000'
grey-green, c., v. calc., felds. subgr.; silica, calcite cements
brown mudst.; black spergenite
1,600'
Unit B
grey-brown mudst.; fine dark subgr.
1,200'
brown mudst.; c., v. felds. subgr., frequent mud clasts; grey sandy spergenite with light coloured lava granules
800'
Unit A
New
400'
Cannindah
Conglomer-
ate Member
grey-green, c. & pebbly felds. subgr.; v. calc. (oolitic) granule cgt.
pebble, cobble, boulder cgt.; c., calc., v. felds. subgr., siliceous cement; grey oolitic lst.
0

Measured section $\frac{3}{4}$ mile south of Dakiel; Portions 15, 16, Parish New Cannindah.


3,300'
3,200'
brown mudst.; grey spergenite; microcoquina; dark siltst.
2,800'
Unit C
2,400'
brown & red-brown mudst.; dark grey spergenite, microcoquina
2,000'
dark green & red-brown, v. calc., pebbly subgr.; brown mudst., oolitic lst.; encrinite
1,600'
Unit B
dark green, c., v. calc. subgr. with calcite, zeolite and chlorite cements; granule cgt.; brown mudst.; oolitic lst.; dark spergenite
1,200'
brown & green-brown mudst.; dark siltst.
800'
light brown & grey, c., v. calc., felds. subgr., some with mud clasts; brown mudst.; oolitic lst. with lava granules
400'
Unit A
New
Cannindah
Cgt.
Member
grey, c. & m., calc., v. felds. subgr., pebbly in part; granule cgt.
brown, pebble & cobble cgt.; grey, v. felds. sub-gr.
0

GRAIN SIZES AS FIG. 1

c

Fig. 3

at the base is a most useful marker horizon. Sub-angular lava fragments of the coarse sand-granule size grade are prominent among large (1·5 mm.) oolites (20–30%), detrital organic calcite, and sparry calcite cement, e.g. R4460 U.Q. The lava fragments are pale green or brown in colour and consist of dacite and trachyte in subequal quantities. Crinoids, algae, bryozoa and brachiopods are the major sources of the detrital calcite. Subgraywacke beds in the lower part of the member are lithologically like those in the New Cannindah Conglomerate, that is, very feldspathic, with acidic and intermediate lava fragments equally abundant. It is particularly characteristic of these sands that they contain dark, elongate mudstone fragments, up to several inches in length, scattered in an haphazard manner through the rock or lying roughly parallel to the bedding plane, e.g. R4461 U.Q. The appearance of such fragments in coarse feldspathic sands seems to be diagnostic of the upper Splinter Creek and lower Dakiel Formations. They may have formed by load disruption of unconsolidated mud interbeds, or where present in quantities, by slumping within an unstable sediment pile. Most recognizable grains in the brown mudstones above and interbedded with the lower arenites of unit B are angular quartz, e.g. R4464 U.Q. Clay stain tests indicate that the clay component is illite with some montmorillonite.

Coarse-grained sediments in the middle and upper parts of unit B vary a great deal along strike. In the north near Dakiel the typical coarse subgraywackes and granule conglomerates are dark green to red-brown in colour due to their high lithic content (60–70%). Virtually all lithic fragments are of intermediate lava, andesite and some trachyte, and are moderately well rounded, e.g. R14526 U.Q. Associated detrital calcite (echinodermal) always forms a considerable proportion of the rock (15–20%); oolites are minor constituents (5%). Calcite, zeolite and bright green chlorite cement the rocks. All these constituents have little resistance to weathering processes and the rock is normally quite crumbly in outcrop. Grey oolitic limestones and encrinites, e.g. R4465 U.Q., and dark spergenites with 30–40% oolites and 15–20% organic calcite in a calcite matrix, are developed at numerous horizons, often associated with calcareous subgraywacke units (fig. 3). In the south near Cannindah Creek only the upper arenite of unit B is represented and no limestones are developed. The grey, medium to coarse-grained subgraywacke beds are very calcareous and appear to have either a different provenance or a different history of reworking, as they are much more feldspathic (25–30%), and some quartz is usually present (5%). Lithics comprise subequal quantities of resistant acidic volcanic detritus (dacitic lava and devitrified vitric tuff), and intermediate lava fragments. Many of these rocks have a recrystallized calcite matrix rather than a true cement, e.g. R14525 U.Q. The rocks to the east of Bancroft are broadly intermediate in character, although many are very feldspathic, e.g. R14524 U.Q. Abundant brachiopod, coral and molluscan faunas occur at various horizons in unit B.

Great changes in sedimentation occur along the syncline again in the uppermost unit C. In the north the unit is almost wholly brown mudstone. Thin fossiliferous grey micro-coquinas and spergenites containing abundant crinoid, coral, brachiopod and bryozoan fragments occur at several horizons. Thickness is approximately 1,400 feet in this area but to the south it wedges out rapidly, so that in the Cannindah Creek area only 450 feet of mudstone, dark grey siltstone (or very fine subgraywacke) and minor coarse subgraywacke are present.

On the eastern limb of the syncline, units B and C are represented by a thick (?1,800 ft.) sequence of mudstone and siliceous argillite, fine subgraywacke, and rarely, coarse subgraywacke beds; a single (3 ft.) sandy spergenite occurs 600 feet above the New Cannindah Conglomerate. In the arenites, lithic content is high (60%) and the predominant acidic lava grains are well rounded; quartz content is low. In some units fine subgraywacke beds three inches to two feet thick, alternate with siliceous argillite and in such cases the rocks are often very noticeably graded and the matrix percentage is high, e.g. R4476 U.Q.

The enormous increase in the thickness of unit C that occurs between Cannindah Creek and Dakiel presents something of a problem. One possible solution is that the southern outcrop areas may originally have been closest to the shore-line, from which beds would increase in thickness into deeper waters to the north and east. The condensed succession of prolific brachiopod-molluscan faunas in the top of the unit B and unit C would support such a proposal.

Fauna (a) Western limb, Yarrol Syncline.

(i) New Cannindah Conglomerate Member.

Brachiopoda:

Leptagonia cf. *analoga* (Phillips)
Kitakamithyris sp. indet.

(ii) Lower part of unit B; locality K.65 G.S.Q.

Brachiopoda:

Rhipidomella sp. indet.
Antiquatonia sp. indet.
Echinoconchus gradatus Campbell

Mollusca:

Baylea sp.

(iii) Upper part of unit B; localities L. 2375, 2389, 2397, 2401, 2403, 2440 U.Q.; K. 3, 4, 31, 82 G.S.Q.

Coelenterata:

Clisiophyllum (?) sp.
Amygdalophyllum sp.
A. cf. *inopinatum* Etheridge fil.
Caninia sp.
Palaeacis aff. *cuneiformis* Haime
Cladochonus sp.

Brachiopoda:
Lingula sp.
Schizophoria aff. *resupinata* (Martin)
Rhipidomella fortimuscula Cvancara
Leptagonia cf. *analoga* (Phillips)
Schellwienella (*Pulsia*) sp.
Quadratia sp.
Pustula cf. *gracilis* Campbell
Eomarginifera tenuimontis Roberts
Inflatia (?) *elegans* Roberts
Rugosochonetes aff. *gloucesterensis* Cvancara
Spirifer lirellus Cvancara
Spirifer aff. *duplicicostus* Phillips
Unispirifer striatoconvolutus (Benson and Dun)
Tylothyris cf. *planimeda* Cvancara
Spiriferellina baywullensis Maxwell
Brachythyris pseudovalis Campbell
Kitakamithyris cf. *triseptata* (Campbell)
Eumetria (?) *mona* Campbell
Composita (?) sp.
Dielasma picketti Roberts
Girtyella (?) sp.

Mollusca:
Bellerophon sp. indet.
Loxonema sp.
Orthonychia sp.
Astartella sp.
Myalina sp.
Pseudaviculopecten (?) sp.

Arthropoda:
Linguaphillipsia cf. *divergens* Cvancara

Echinodermata:
Nymphaeoblastus bancroftensis McKellar

(iv) Unit C; localities L2385 U.Q.; K.32, 61 G.S.Q.

Coelenterata:
Palaeacis aff. *cuneiformis* Haime

Brachiopoda:
Rhipidomella fortimuscula Cvancara
Werriea australis Campbell
Schellwienella (*Pulsia*) sp.
Pustula cf. *gracilis* Campbell
Eomarginifera tenuimontis Roberts
Spirifer lirellus Cvancara
Unispirifer striatoconvolutus (Benson and Dun)
Tylothyris planimeda Cvancara
Kitakamithyris triseptata (Campbell)
Composita (?) sp.
Eumetria (?) cf. *mona* Campbell
Camarotoechia (?) sp.
Balanoconcha elliptica Campbell

Mollusca:
Beyrichoceras spp.
Pseudaviculopecten (?) sp.
Astartella sp.

Arthropoda:
Linguaphillipsia cf. *divergens* Cvancara

(b) Eastern limb, Yarrol Syncline

(i) Unit B; locality L2441 U.Q.

Coelenterata:
Palaeacis cf. *cuneiformis* Haime

Brachiopoda:
Schizophoria aff. *resupinata* (Martin)
Rhipidomella fortimuscula Cvancara
Inflatia (?) *elegans* Roberts
Brachythyris pseudovalis Campbell
Composita (?) sp.

Mollusca:
Astartella sp.

Age and Stratigraphic Relationships

The faunas are all of Viséan age, and more precisely, probably of the middle or upper Viséan. It seems most likely that the Dakiel Formation is succeeded conformably by the Baywulla Formation. On lithology and fauna, the formation, at least in its upper part, correlates with that portion of the Tellebang Formation east of the fault dividing its type section in the Yarrol region (Maxwell, 1959, 1960). It is also thought to be equivalent to the combined O'Bil Bil Road Conglomerate and Mundubbera Sandstone in the area immediately to the north-west of Mundubbera (Driscoll, 1960). In the Cannindah Creek area the boundary between these formations would probably be placed in the lower part of unit B, Dakiel Formation.

BAYWULLA FORMATION

The formation was named by Maxwell (1959, p. 29) and has its type section along the road immediately to the south-east of the Baywulla road crossing on the Burnett River, Parish Baywulla, County Yarrol. The sequence of lithologies in that area is as follows:

(1) A lower unit comprising three main oolitic limestones with interbedded fine calcareous subgraywacke.
(2) A middle unit of medium to coarse-grained subgraywacke and minor polymictic conglomerate.
(3) An upper unit of two or three main limestones, the topmost sandy, and interbedded medium-grained subgraywacke.

Thickness in the Yarrol region has been quoted as between 900 and 1,100 feet (Maxwell, 1959, 1964). It is quite variable in the Cannindah Creek area, with a minimum of 350 feet near Dakiel, approximately 600 feet near Branch Creek to the east of Bancroft, and a maximum of 650–700 feet south of Cannindah Creek. In the southern part of the Yarrol Basin the formation is readily recognized from Kalpowar to the Mundubbera district. In the Cannindah Creek area its boundaries are moderately well defined on the western limb of the syncline, even though the facies is much less calcareous than it is in the type area. Out-

crop in this area is usually excellent and the formation forms a single moderately elevated strike ridge. Recognition of the top of the formation on the eastern limb of the syncline is difficult as sediments are all rather fine-grained and the upper limestone is not developed; topographic expression here is subdued and outcrop far from complete.

Stratigraphic Succession

In the stratigraphic column (fig. 4), unit A is illustrated in its maximum development with three relatively thick, and two very thin grey oolitic limestone beds and interbedded light grey, fine and medium-grained subgraywacke; however, the unit is represented by a single limestone only near Dakiel. Thickness of the lowest limestone bed is up to 30 feet. In these limestones, oolites (60–70%) are up to 1·5 mm. diameter, and either have no visible nucleus, or nuclei of organic calcite and less frequently terrigenous material (sodic plagioclase, quartz, acidic and intermediate lava grains). Echinoderm, coral and bryozoan fragments occur as oolite nuclei or as discrete grains (10%). Strong concentric structure is preserved in most oolites; indistinct radial structures visible in many may have developed during inversion of the original aragonite to calcite. Free, uncoated terrigenous grains constitute less than 5% of the limestones. In one sample from the lowest limestone R4469 U.Q. light coloured prismatic crystals with rhomboidal section occur within and transecting the boundaries of oolites; they are thought to be gypsum. Sparry calcite cements these rocks.

Unit B has a strong grey-green to red-brown polymictic conglomerate bed 15–20 feet thick at its base over most of the map area, but near Dakiel the rudaceous fraction is reduced and the bed becomes a coarse pebbly subgraywacke. Pebbles and granules in this rather poorly sorted conglomerate are moderately rounded, non-faceted, and most are composed of devitrified vitric tuff; finer grades have grains of tuff and acidic lava in similar proportions to the intermediate lava fragments, e.g. R4470 U.Q. Overlying beds of coarse subgraywacke and granule conglomerate are well bedded, and at times cross stratified. They are not calcareous, but are relatively quartz rich (15%), and may be distinguished by their considerable content of devitrified tuff (25–35%). Most acidic lava fragments (30%) are rhyolite, and among material derived from intermediate lava (15%), trachyte is dominant. In these sediments only the lithic grains are appreciably rounded. Higher sands in the unit are grey-green in colour and the feldspar, mainly sodic plagioclase, is frequently very abundant (25%), e.g. G.S.Q. 4003. Microcrystalline silica is the cement in these rocks.

Facies change along strike is most marked in the upper calcareous unit C. Bedded, lutaceous limestone (20 feet) occurs at its base near Dakiel. Toward Branch Creek a rapid alternation of oolitic and sandy layers ¼–½ inch thick occur in the bed and give the rock a characteristic bladed surface when weathered, e.g. R4472 U.Q. In the more calcareous layers, oolites are small and have proportionately large nuclei of plagioclase feldspar, quartz and minor acidic lava grains. They lie in a coarsely recrystallized calcite matrix. A little further south, clean, well bedded grey oolitic limestone occurs, but the beds become sandy again toward Cannindah Creek. Between the limestone and a massive conglomerate regarded as the base of the Branch Creek Formation, there is approximately 100 feet of subgraywacke. Lower beds are calcareous, grey-green, medium-grained subgraywacke with a fauna of partly silicified Lower Carboniferous brachiopods. Upper beds of coarse, non-calcareous, green subgraywacke have grains of red-pink feldspar, mostly sodic plagioclase, prominent among fragments of devitrified tuff, and acidic and intermediate lava, e.g. G.S.Q. 4002.

Fauna

(a) Western limb, Yarrol Syncline.

(i) Unit A; locality L2324 U.Q.

Coelenterata:
Palaeacis cf. *cuneiformis* Haime

(ii) Unit C; localities L2371, 2399 U.Q.; K.63 G.S.Q.

Coelenterata:
Palaeacis cf. *cuneiformis* Haime

Brachiopoda:
Schuchertella aff. *pseudoseptata* Campbell
Pustula aff. *abbotti larga* Cvancara
Marginirugus barringtonensis (Dun)
Spirifer aff. *bifurcatus* Hall

(b) Eastern limb, Yarrol Syncline; localities L2451, 3020 U.Q.

Coelenterata:
Caninia sp.

Brachiopoda:
Marginirugus barringtonensis (Dun)
Tylothyris (?) *multicostatus* Maxwell

Age and Stratigraphic Relationships

The fauna is thought, mainly on the grounds of superposition, to be late Viséan in age, although the possibility of an early Namurian age must be admitted as the *Spirifer bifurcatus* Hall—*S. leidyi* Norwood and Pratten group of spiriferids range over this interval in North America.

The relationship of the Baywulla Formation to the overlying conglomerate-subgraywacke sequence of the Branch Creek Formation was considered to be disconformable by McKellar (1965). The brachiopod fauna of the Branch Creek Formation is indicative of a Westphalian, and probably middle Westphalian, age; so that a non-sequence spanning the Namurian and early Westphalian Stages must be postulated. Changes in sediment type at the Baywulla-Branch Creek interface are certainly indicative of source and depositional environment changes and appear to support the proposed diastem. In contrast to calcareous sediments in

REPRESENTATIVE SECTIONS OF BAYWULLA AND BRANCH CREEK FORMATIONS

Baywulla Fm. : Measured section on Branch Creek in southern part Portion 38, Parish Cannindah, County Yarrol.

Branch Ck. Fm. : Measured section $\frac{3}{4}$ mile south-east of above, in western part Portion 74, Parish Cannindah.

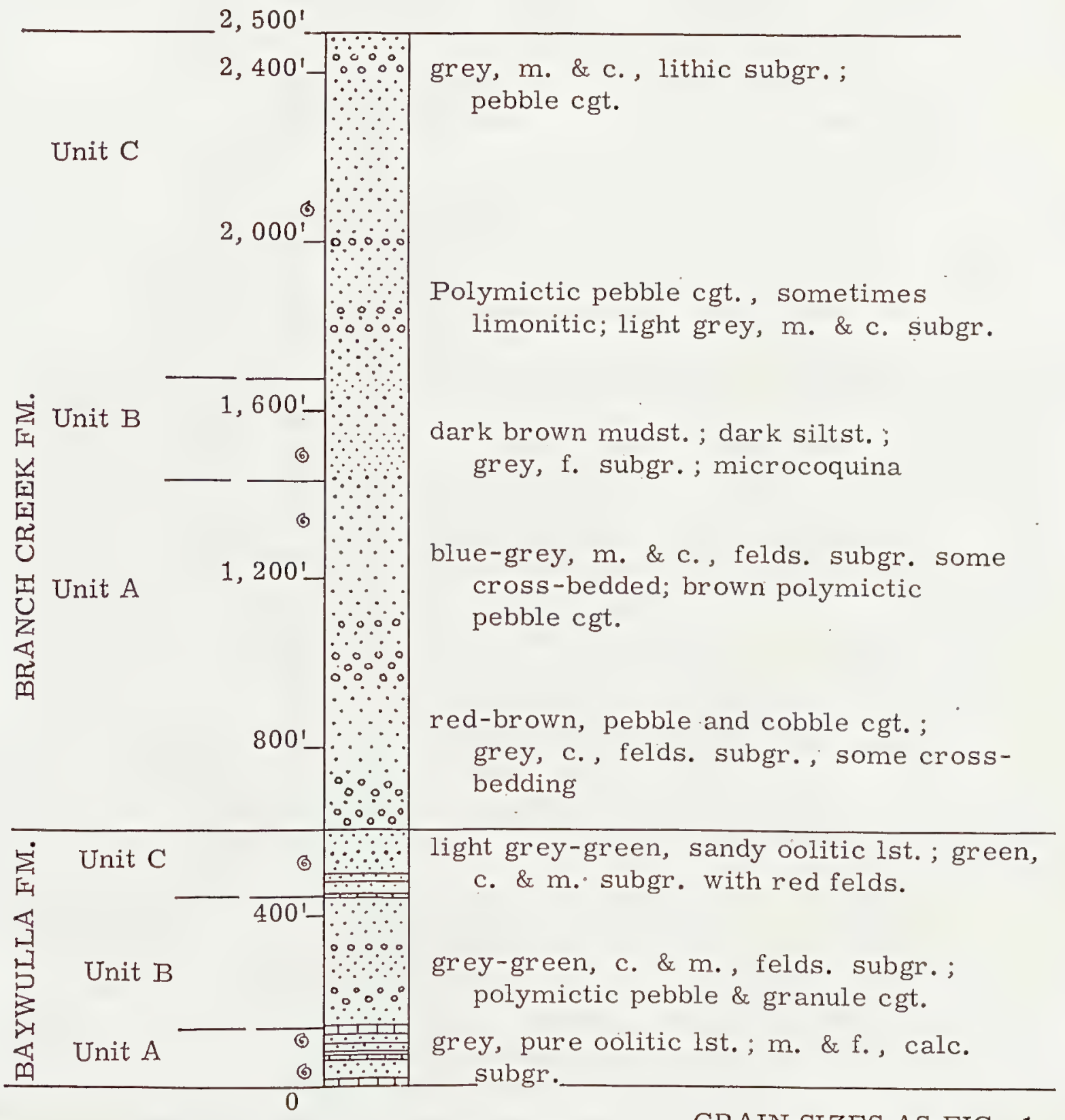

2,500'
2,400'
grey, m. & c., lithic subgr.; pebble cgt.
Unit C
2,000'
Polymictic pebble cgt., sometimes limonitic; light grey, m. & c. subgr.
BRANCH CREEK FM.
Unit B
1,600'
dark brown mudst.; dark siltst.; grey, f. subgr.; microcoquina
Unit A
1,200'
blue-grey, m. & c., felds. subgr. some cross-bedded; brown polymictic pebble cgt.
800'
red-brown, pebble and cobble cgt.; grey, c., felds. subgr., some cross-bedding
BAYWULLA FM.
Unit C
light grey-green, sandy oolitic lst.; green, c. & m. subgr. with red felds.
400'
Unit B
grey-green, c. & m., felds. subgr.; polymictic pebble & granule cgt.
Unit A
grey, pure oolitic lst.; m. & f., calc. subgr.
0
GRAIN SIZES AS FIG. 1

Fig. 4

the Caswell Creek Group, those in the Branch Creek Formation, and others of the Boiling Creek Group, are non-oolitic. In the Boiling Creek Group volcanic detritus remains the essential rock building material, but lava fragments are regularly more acidic and fall in the composition range, rhyolite to trachyte. Andesitic lava fragments that constitute the thick dark green subgraywacke units in the Lower Carboniferous formations, are rarely seen in the Upper Carboniferous rocks. Granite-derived detritus makes its appearance also in the rocks of the Branch Creek Formation. To this evidence may be added the occurrence of silicified brachiopod shells in the uppermost sands of the Baywulla Formation. The silicification may have occurred during a period of exposure and erosion prior to deposition of the Branch Creek Formation.

The Baywulla Formation is almost certainly represented, in part at least, by the Killala Creek Limestone (Driscoll, 1960) in the Mundubbera area.

BOILING CREEK GROUP

The group is designed to include the Branch Creek, Poperima and Rands Formations of Maxwell (1959, 1960), and has a thickness in excess of 7,000 feet. Its name is derived from Boiling Creek, a tributary of Cannindah Creek, which drains the axial zone of the syncline in the southern part of the map area. The type area is regarded as the Yarrol Syncline in the Cannindah Creek and Yarrol areas, to the east and south-east of Monto respectively. Constituent formations are considered to represent a broad lithogenetic unit. Subgraywacke and conglomerate are rather light coloured, grey and brown. They are feldspathic, and their abundant lithic fraction includes rhyolite, trachyte and devitrified tuff fragments. Calcareous arenites and limestones are detrital, but never oolitic. Mudstone does not differ noticeably from that in the underlying Caswell Creek Group. The group is presumed to be Upper Carboniferous (Westphalian and Stephanian) in age; however, little critical work has been done on faunas from the upper part of the Rands Formation, and some of these beds could possibly be early Permian in age.

Should future detailed study of lithologies in the overlying Permian Burnett Formation show them to be very similar in character to those of the Rands Formation, it may be desirable to include the formation in the Boiling Creek Group. The Yarrol and Owl Gully Formations in the Permian present an entirely different sedimentary aspect and are clearly separated from the group. Their lithologies are detrital limestone, dark siltstone and andesitic lava and tuff.

BRANCH CREEK FORMATION

The formation was named by Maxwell (1959, p. 28), and has its type section just to the south-east of the Baywulla road crossing on the Burnett River in Parish Baywulla, County Yarrol. The type section continues to the east from that of the Baywulla Formation. He listed the lithologies as subgraywacke, conglomerate and argillite, and recently estimated thickness in the Yarrol region as 860–1,400 feet (Maxwell, 1964, p. 6). In the Cannindah Creek area, thickness is approximately 1,900 feet on both limbs of the syncline, and remains fairly constant over the map area. The formation has been recognized around the Yarrol Syncline from Kalpowar, at its northern closure, to Baywulla Creek south of Yarrol station. Near Cannindah Creek it outcrops boldly on the western limb of the syncline as two broad, high strike ridges separated by a narrow valley. The ridges are representative of the lower and upper conglomerate-subgraywacke units, the valley, of the intervening fine subgraywacke-calcareous mudstone unit. On the eastern limb of the syncline, fine subgraywacke is the prevalent lithology, and the formation has its expression in lower hilly country without well developed strike ridges.

Stratigraphic Succession

The succession of lithologies to the east of Bancroft is illustrated in fig. 4. Unit A has a persistent, thick, poorly sorted conglomerate with pebbles and cobbles up to three inches in diameter at its base. The rock is grey-brown in colour, non-calcareous, and its abundant lithic granules and pebbles (70%) comprise almost equal quantities of acidic volcanic material (devitrified tuff, rhyolite and dacite) and intermediate lava (trachyte); clear unstrained quartz and sodic plagioclase are minor constituents, e.g. G.S.Q. 4001. Epidote is often the primary cement; remaining cavities are filled by microcrystalline silica and some chlorite. Other conglomerate beds occur near the middle of the unit, but medium and coarse-grained subgraywacke is the most important lithology. These arenites are usually very evenly bedded, although cross-stratification has been observed in certain of them. They are light blue-grey in colour, and while lithic content is high (50%), feldspar (15–20%), mostly albite and oligoclase, and quartz (10–15%), some with irregular extinction, are very important components G.S.Q. 4000. Of the lithic grains, 40–45% is acidic volcanic detritus; intermediate lava and granophyre grains are minor constituents. Cements are siliceous, with secondary chlorite and some calcite.

Lithologies in the richly fossiliferous unit B are grey, fine-grained subgraywacke, dark calcareous mudstone, and detrital limestone. The limestone occurs sporadically in the main faunal beds (20–30 feet), where bryozoa, crinoids and brachiopods have accumulated in sufficient quantities.

In the upper unit C, thick grey conglomerate beds occur near the base and toward the top (fig. 4). Pebbles are well rounded and have an average diameter of ½–1 inch. Most are composed of acidic lava and siliceous devitrified tuff (possibly an ignimbrite) containing grains of quartz and sodic plagioclase, e.g. R4474 U.Q. Light cream or grey granite pebbles occur rarely in them, e.g. R4475 U.Q. Cements are often ferruginous (limonite), but some microcrystalline silica is also usually present at grain contacts. Subgraywacke in the member is light grey and medium-

grained in the northern part of the area, but south of Cannindah Creek it is considerably finer and darker. Lithic grains, almost entirely acidic lava and tuff, are the main rock constituents (70%).

On the eastern limb of the syncline, fine subgraywacke is the dominant lithology, conglomerate is restricted to a single horizon where it reaches a maximum thickness in the order of 20 feet, and detrital limestone occurs on two horizons (McKellar, 1965, fig. 3). As mentioned in the discussion of the Baywulla Formation, a thin, light grey, coarse arkose bed was tentatively selected as the base of the formation on this limb. The rock has approximately 60% slightly sericitized sodic plagioclase, of which much is subhedral, and 5–10% acidic lava grains in a recrystallized calcite matrix, e.g. G.S.Q. 4005. A grey, fairly pure detrital limestone (6 feet), some 250–300 feet above the base of the formation contains an abundance of the bryozoans *Fenestella* and *Evactinopora,* and occasional specimens of the brachiopod *Neospirifer campbelli* Maxwell. Beds of coarse-grained, blue-grey subgraywacke 650 feet above the base also grade to limestone in their upper part. The limestone has 30–40% detrital calcite (echinoderm, bryozoa and brachiopod fragments) and 20–25% terrigenous material comprising subequal quantities of quartz and sodic plagioclase together with minor acidic lava grains, in a calcite matrix. Oolites are not developed. Pebble conglomerate occurs on the same horizon as that low in unit C on the western limb. The rock is green-brown in colour and most pebbles are composed of acidic lava and devitrified tuff, e.g. R4479 U.Q.

Fauna

(a) Western limb, Yarrol Syncline.

(i) Uppermost unit A, unit B; localities K.2, 37 G.S.Q.; L.2377, 2378, 2388, 2400 U.Q.

Bryozoa:

Evactinopora sp.
Fistulamina frondescens Crockford
Fenestella spp.

Brachiopoda:

Levipustula levis Maxwell
Neospirifer campbelli Maxwell
Alispirifer laminosus Campbell
Punctospirifer hirsutus McKellar
Athyris lamina McKellar
Kitakamithyris booralensis (Campbell)
Beecheria sp.

Mollusca:

Limipecten cf. *multistriatus* Maxwell

(ii) Upper part, unit C.

Bryozoa:

Fistulamina frondescens Crockford

(b) Eastern limb, Yarrol Syncline

(i) Unit B; localities L.2442 U.Q.; K.41, 59, 60 G.S.Q.

Coelenterata:

Cladochonus sp.

Bryozoa:

Evactinopora sp.
Fistulamina frondescens Crockford
Fenestella spp.

Brachiopoda:

Werriea regina McKellar
Levipustula levis Maxwell
Inflatia dakielis McKellar
Lissochonetes montinis McKellar
Neospirifer campbelli Maxwell
N. campbelli exora McKellar
Alispirifer sp.
Punctospirifer hirsutus McKellar
Athyris lamina McKellar
Lissella booralensis Campbell
Indet. dielasmatid

Mollusca:

Pseudobaylea (?) sp.
Stephanozyga (?) sp.
Schizodus spp.
Sanguinolites sp.
Limipecten sp. indet.
Myalina sp.

Arthropoda:

Australosutura gardneri (Mitchell)

Age and Stratigraphic Relationships

The Branch Creek faunas from the eastern limb of the Yarrol Syncline were described by McKellar (1965), and a probable middle Westphalian age suggested. The unit is conformably overlain by the Poperima Formation.

POPERIMA FORMATION

The formation was defined by Maxwell (1959, p. 30), and has its type section north-east of the Baywulla road crossing on the Burnett River in Parish Baywulla, County Yarrol. As I understand it, the formation comprises the mudstone unit between the uppermost subgraywacke or conglomerate bed of the Branch Creek Formation and the next overlying subgraywacke unit (often pebbly) taken as the base of the Rands Formation. Regionally, the formation is known to outcrop around the Yarrol Syncline from Kalpowar to Baywulla Station. In its type area, the Yarrol region, its thickness is estimated at 800 feet on the western limb of the syncline, and 1,300 feet on the eastern limb (Maxwell, *op. cit.*).

About Cannindah Creek, in the present map area, it has fairly constant thickness, of the order of 550 feet, on the western limb of the syncline. Eastern limb thicknesses appear to be similar, although it is just

possible that the overlying sandstone unit may not be equivalent to that at the base of the Rands Formation on the western limb, in which case thickness would be considerably greater. This doubt is caused by the presence of one foot of grey detrital limestone and a thickness of mudstone with *Levipustula levis* Maxwell, 150 feet above the sandstone unit in the section along Cannindah Creek, but for consistency, these beds are referred to the Rands Formation. The Poperima Formation has its topographic expression in a moderately broad strike-valley with its limestone unit represented by a sharp, narrow ridge along one flank.

Stratigraphic Succession

Poorly laminated mudstones that comprise most of the Poperima Formation are grey-green at the base, but brown to green-brown in colour higher in the sequence. Microscopic grains in the mudstone include angular quartz, and relatively minor feldspar and fine light-coloured micas; less than 5% carbonaceous material is present. Clay stain tests using Crystal Violet, Safranine γ, and Benzidine (method of Le Roy, 1950) were applied to crushed, acid treated samples from three localities. Results were consistent, and indicated that the clay component was very largely illite, with a trace of montmorillonite; no kaolin was recognized. Near Dakiel a thin pebble bed is developed 50–80 feet above the base of the formation, but it is laterally discontinuous. By contrast, the thin black limestone (5–10 feet) approximately 420 feet above the base of the formation (fig. 5) is remarkably persistent and has been recognized on the western syncline limb from "Yarrol" to Dakiel. The limestone has much organic detritus (40%), almost entirely fenestrate bryozoa and crinoids, in a dark, semi-opaque, calcite matrix; occasional brachiopods are found in the limestone.

Fauna

As the faunas on western and eastern limbs of the syncline are almost identical, they are not separated here.

(i) Basal mudstone and shale; localities L.2315-7, 2326, 2328, 3022-3 U.Q.

Bryozoa:
Fenestella spp.
Polypora sp.

Brachiopoda:
Levipustula levis Maxwell
Neospirifer pristinus Maxwell
Spiriferellina neerkolensis Maxwell
Indet. dielasmatid

(ii) Mudstone above the limestone; localities L.2320, 2395 U.Q. in the upper 50 feet of the formation.

Bryozoa:
Fenestella spp.

Brachiopoda:
Spinuliplica spinulosa Campbell

Age and Stratigraphic Relationships

The formation is very probably Upper Carboniferous (Westphalian) in age. It is conformably succeeded by the Rands Formation.

RANDS FORMATION

The formation was named by Maxwell (1959, p. 30) and has its type section in Parishes Yarrol and Tellebang, County Yarrol, extending westward half-a-mile from Rands Creek across the divide marking the parish boundary into the watershed of Tellebang Creek (Maxwell, 1964, fig. 1). Maxwell (*op. cit.*) now subdivides the formation into a lower unit (1,600 feet) of subgraywacke, interbedded shale and some limestone, and an upper unit (3,400 feet), mainly shale. The boundary of these units was indicated on the above mentioned text figure. About Cannindah Creek, where the formation is truncated in the axis of the syncline, 2,500–2,600 feet of strata are present; 2,000 feet in the lower unit, 500–600 feet in the upper unit.

The formation occupies the axial zone of the Yarrol Syncline from Kalpowar to the area south of Cannindah Creek where it is obscured by lateritized Tertiary sediments. In the Yarrol region, it is overlain by thick Lower Permian strata of the Burnett, Yarrol and Owl Gully Formations. In this area the formation outcrops on the limbs of the syncline (Monto 1:250,000 sheet). In the map area, the lower unit in the formation produces rough topography with a close succession of sharp strike ridges and narrow valleys. The upper unit occupies the axial portion of the syncline where dips are low, and the low "broken" country with irregular drainage pattern that is typical of such areas results.

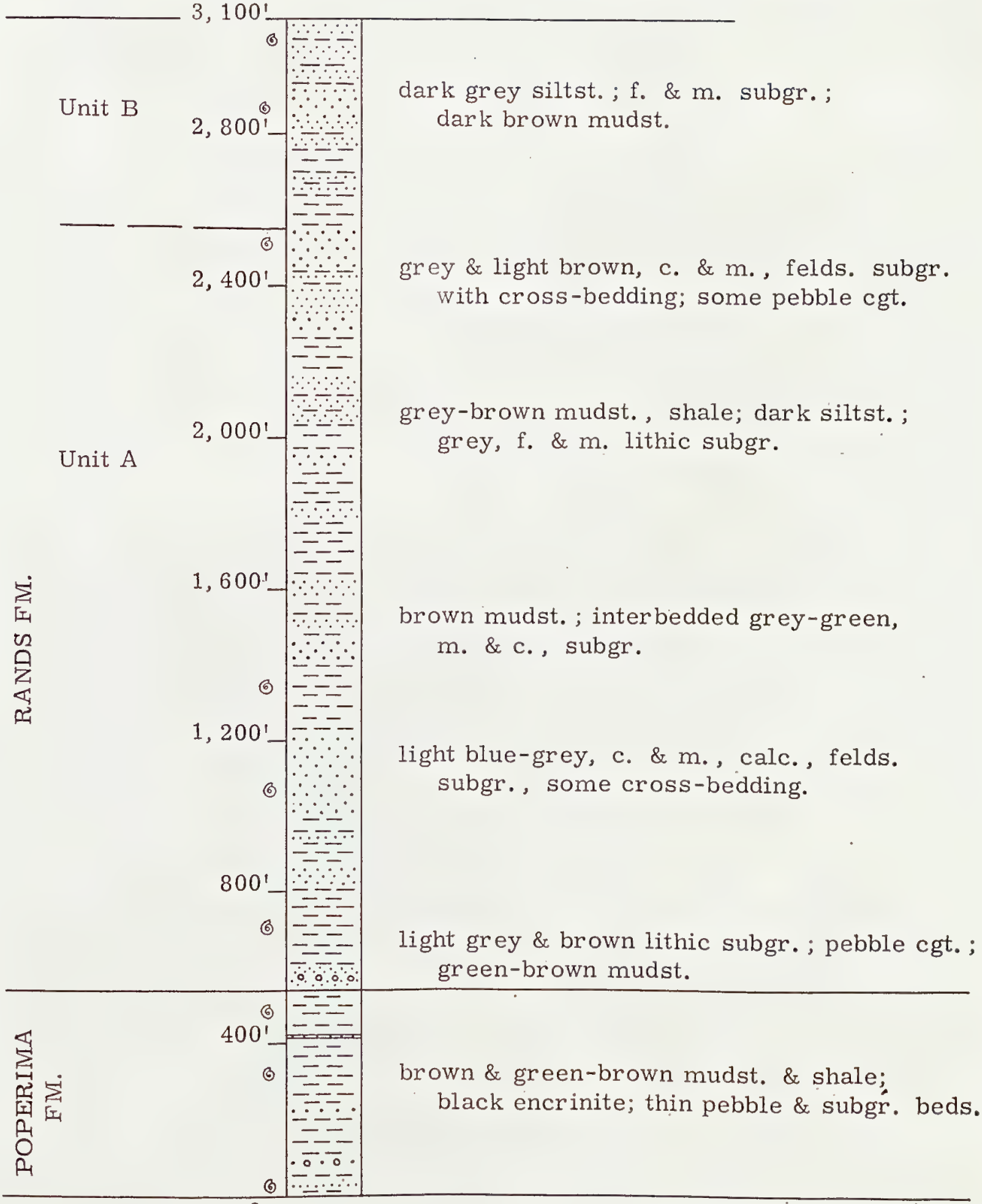
Stratigraphic Succession

The succession of lithologies in the north of the map area is indicated on figure 5. Unit A presumably corresponds to Maxwell's lower subdivision of the formation. It has four major, medium and coarse-grained subgraywacke units with intervening sequences of mudstone, shale and fine lithic graywacke. Pebble conglomerate beds occur in each of the arenite units, excepting that 850 feet above the base of the formation.

Considering the major arenite units generally, the rocks are light cream, grey or grey-green subgraywacke and most have a considerable lithic content (60%). Of the lithic grains, finely siliceous acidic lava fragments (30–40%), mostly rhyolite, are a little more abundant than intermediate lava (trachyte) grains (20–25%); as much as 5% of granophyre grains may also be present. Lithic grains are nearly always moderately to well rounded. Quartz (5–10%) is apparently derived from a variety of sources as strained, composite, and clear embayed grains are evenly intermingled, e.g. R4484 U.Q. Much of the feldspar (15–20%) is sodic plagioclase, but some potash feldspar is also typically present. Feldspars are usually sericitized and slightly to moderately rounded. Microcrystalline silica with some chlorite normally cements these rocks, but the unit 450 feet above the base has some beds with clear sparry calcite cement, e.g. R14527 U.Q. The largest conglomerate development

REPRESENTATIVE SECTIONS OF POPERIMA AND RANDS FORMATIONS

Measured section from 1/3 mile east of Dakiel extending east to axis of Yarrol Syncline; Portion 17, Parish New Cannindah, County Yarrol


3, 100'
Unit B
2, 800'
dark grey siltst. ; f. & m. subgr. ; dark brown mudst.
2, 400'
grey & light brown, c. & m., felds. subgr. with cross-bedding; some pebble cgt.
2, 000'
Unit A
grey-brown mudst., shale; dark siltst. ; grey, f. & m. lithic subgr.
RANDS FM.
1, 600'
brown mudst. ; interbedded grey-green, m. & c., subgr.
1, 200'
light blue-grey, c. & m., calc., felds. subgr., some cross-bedding.
800'
light grey & brown lithic subgr. ; pebble cgt. ; green-brown mudst.
400'
POPERIMA FM.
brown & green-brown mudst. & shale; black encrinite; thin pebble & subgr. beds.
0

GRAIN SIZES AS FIG. 1.

Fig. 5

in unit A occurs in the upper arenite in the north of the map area. This conglomerate is moderately sorted, although bimodal, and pebbles of 1–2 inches diameter are bound by a limited arenaceous matrix. Pebbles are rounded, non-faceted, and most are composed of chalcedony and acidic lava fragments. The former are presumably derived from devitrified vitric tuff, as some have included grains of feldspar and volcanic quartz.

Mudstone in unit A is dark grey-brown when fresh, light brown when weathered, and illite is the main clay component. Dark siltstone and fine lithic graywacke interbedded with the mudstone, occur particularly in the beds beneath the upper arenite. These rocks have subequal quantities of rather angular quartz, sodic plagioclase and acidic lava grains in a matrix (20–30%) of extremely fine siliceous material and clay, e.g. R4486 U.Q. Some light coloured detrital mica is nearly always present.

The 500–600 feet of sediment in unit B probably corresponds with the lower part of Maxwell's upper subdivision of the Rands Formation. Its dark, fine-grained rocks present quite a different aspect to those of unit A as a whole, although they are certainly similar to those described above from beneath the upper arenite. Dark grey, massive siltstone, very fine graywacke and dark brown mudtsone are the most important lithologies and occur in thick units, whose magnitude is falsely accentuated by their subhorizontal attitude near the synclinal axis. Recognizable grains in the silts and arenites include quartz (20–30%), and some sodic plagioclase and fine siliceous material, possibly an acidic lava; 2–3% carbonaceous fragments are usually present. Matrix (40%) comprises clay and finely divided siliceous particles, e.g. R4489 U.Q. As in the older member mudstone and shale has a clay component of illite and some montmorillonite.

Fauna

Faunas from the western and eastern limbs of the syncline are not distinguished in the following list.

(i) Unit A, mudstone 150 feet above the base; locality L. 2310 U.Q.

Bryozoa:
Fenestella spp.
Polypora sp.

Brachiopoda:
Levipustula levis Maxwell
Spiriferellina neerkolensis Maxwell

(ii) Unit A, subgraywacke 450 feet above the base; localities L. 2307, 2380, 2382 U.Q.

Mollusca:
Indet. gastropod
Schizodus elliotti Maxwell

(iii) Unit A, subgraywacke 1,900 feet above the base; locality L. 2381 U.Q.

Mollusca:
Schizodus elliotti Maxwell

(iv) Unit B, numerous horizons; localities L. 2311, 2313, 3024 U.Q.

Bryozoa:
Fenestella spp.
Polypora sp.
Rhombopora sp.

Brachiopoda:
Punctospirifer ambiguus Maxwell
Spiriferellina neerkolensis Maxwell
Beecheria sp.

Mollusca:
Planikeenia pristina Maxwell
Limipecten burnettensis Maxwell

Age and Stratigraphic Relationships

The situation of this very thick formation between units of known Upper Carboniferous (Westphalian) and Lower Permian (Sakmarian) age presupposes an Upper Carboniferous (Stephanian) age for the greater part of it. Some of the molluscan faunas have been described by Maxwell (1964), but most of these are unsuitable for precise inter-continental correlation and age determination. As the upper part of the Rands Formation is incomplete in the Cannindah Creek area, I cannot comment on its relationship with the overlying Burnett Formation.

MUNCON VOLCANICS

The formation will be defined by Dear (1967) from the Cania area to the north west of Monto. It is an extremely extensive unit and unconformably overlies folded Upper Palaeozoic rocks over considerable areas of the Yarrol Basin, and areas immediately marginal to it. About Cania more than 600 feet of silt and basic lava and agglomerate occur, but even greater thicknesses are present about Kalpowar, east of Builyan, and to the west of Degalgil Creek (Monto 1:250,000 sheet). Thickness preserved in the north-east of the Cannindah Creek map area is probably close to 200 feet, and lithologies include green and purple-brown intermediate and basic lava, tuff and agglomerate. Floras of Middle Triassic age have been collected from tuff and dark shale close to the base of the sequence at Cania, near Barrimoon siding north of Kalpowar, and to the east of Builyan. The unit appears to be at least partly equivalent to the Neara Volcanics in the Esk Basin.

TERTIARY SEDIMENTS AND LAVAS

Some thin, subhorizontal cappings of coarse-grained, ferruginous, quartzose sandstone and conglomerate unconformably overlie the folded Carboniferous rocks in the south of the map area. The beds are a marginal erosion remnant of the thick sequence of lateritized Tertiary sediments that occur between the Cannindah Creek and Yarrol areas. It is interesting to note that the lateritic processes of the Tertiary had relatively

little influence on the Upper Palaeozoic sediments. This could relate to the screening effect of the Tertiary sediments which appear to have been very thick and possibly also to the relative imperviousness to solution of the tightly cemented Palaeozoic rocks. No fossils have been found in Tertiary sediments in the map area, but silicified dicotyledonous wood has been collected by the writer from an outlier immediately to the south-west of Mt. Tellebang. The Monto Shire Council obtains much of its road gravel requirements from this outlier.

Basalt cappings overlie the folded Carboniferous along a ridge one and a half miles south-east of Dakiel, and the Triassic Muncon Volcanics in the north-east of the map area. This black, often vesicular, very fresh lava is quite different in appearance to the deeply weathered Muncon Volcanics. The basalt is porphyritic with abundant olivine phenocrysts (up to 2 mm.) in a ground mass of plagioclase laths and clinopyroxene with an intergranular relationship. Black opaque iron oxide constitutes 10% of the rock, e.g. R4490 U.Q.

SEDIMENTATION

The broader aspects of Carboniferous sedimentation in the Cannindah Creek area are discussed in terms of the subheadings: provenance, transportation, depositional environment, lithification, basin shape, and controls for sedimentation.

Provenance

Source rock types can be inferred usually from a detailed examination of the components of the terrigenous sediments. In the Yarrol Basin, volcanic rock detritus dominates all the Carboniferous sediments, although its character does change quite considerably through the sequence. Coarse-grained sediments with a high proportion of lava fragments of andesitic composition, and typically very dark green or reddish in colour, occur in the lower and upper units of the Crana Beds, the Splinter Creek Formation, excepting perhaps its uppermost beds, and the middle unit B of the Dakiel Formation. Acidic lava fragments, mainly dacite and rhyolite, are most prevalent in the grey and light brown arenites and rudites in the lower half of the Bancroft Formation and New Cannindah Conglomerate Member of the Dakiel Formation. In sediments of the Baywulla, Branch Creek and Rands Formations, the acidic and intermediate lavas are almost equally well represented, but of the latter, most most is trachyte rather than andesite. Fragments of devitrified vitric tuff are very abundant in the Baywulla and Branch Creek Formations. Much of this material has relict shard structures visible in plane-polarized light, and has included fragments of quartz and plagioclase feldspar crystals. It may have its origin in ignimbrite tuff beds. Granophyre grains are ubiquitous, but volumetrically insignificant; their presence associated with materials derived from a volcanic complex is not surprising.

Feldspar occurs in all rock units, and this too is consistent with a source in volcanic rocks. Sodic plagioclase, largely oligoclase, becomes abundant in most of the units where acidic lava fragments outweigh, or equal, intermediate lava fragments. The sands of the Bancroft Formation and New Cannindah Conglomerate are particularly feldspar-rich, with plagioclase grains constituting 25–35% of most rocks. True arkose with 60% plagioclase feldspar has been recognized from the base of the Branch Creek Formation on the eastern synclinal limb, but such rocks are rare. Quartz is never very abundant in the succession, but its maxima of 10–15% also coincide with high acidic lava contents in the sediments. In Lower Carboniferous formations almost all quartz is clear, frequently subhedral or embayed, and unstrained, i.e. apparently with a volcanic source. In Upper Carboniferous formations nearly half of the quartz is strained and composite grains are frequently observed, indicating supplementary sedimentary or deep-seated igneous sources. Infrequent, light-coloured granite pebbles in the Branch Creek and Poperima Formations establish one additional source rock type.

The clay component of mudstone and shale, being very largely dependent on the source rock, also has considerable importance. Clay stain tests using Benzidine, Crystal Violet and Safranine γ were applied to acid treated samples from the Dakiel, Poperima and Rands Formations. The results were complementary, and in each case the clay was illite with some montmorillonite. Illite may be derived from muscovite degradation, or hydrolysis of volcanic glass; montmorillonite from volcanic glass.

In summary, acidic and intermediate lavas and tuffs are the most important sediment source, but granitic and possibly sedimentary or metamorphic sources also contribute material in the Upper Carboniferous. Middle and Upper Devonian lava and tuff sequences that have been mapped as Kroombit Beds in the area to the east of Biloela on the Monto 1:250,000 geological sheet, could be a major source of sediment. Contemporaneous vulcanicity may account for much other material. The subtle sediment changes between the Lower Carboniferous Baywulla Formation and Upper Carboniferous Branch Creek Formation were thought to lend support for the disconformity recognized at this interface, primarily on faunal evidence, by the author (McKellar, 1965).

Transportation

In arenaceous and rudaceous sediments whose transportation has taken place by traction, grain rounding is often the most reliable measure of transportation.

It has been found that the amount of rounding, visible on grains of each of the several components in the Carboniferous sediments, is fairly constant through the whole succession. Intermediate lava fragments are invariably well rounded and have a microscopically "ragged" or roughened surface. The acidic lava and devitrified tuff grains are moderately rounded in arenites, and exceptionally, as in granule conglomerate in the uppermost beds of the New Cannindah Conglomerate Member, they are sub-angular or angular. Feldspars are only slightly rounded, although very small grains are sometimes quite well rounded. Fractured quartz is uniformly quite angular with little

or no evidence of abrasion. Protracted transportation is not necessarily indicated by the occurence of well rounded lithic fragments, as such grains are worn rapidly. The presence in most sediments of quantities of intermediate lava grains, which are presumed to be mechanically unstable, appears to be more significant. They suggest that transportation was in fact limited, and the degree of rounding of feldspar grains would be consistent with this. Quartz in its first sedimentary cycle is nearly always angular (Pettijohn, 1957; Thiel, 1940).

Almost all sediments in the described formations on the western limb of the syncline are simply laminated or cross-bedded; poorly sorted, high matrix sediments with pronounced grading, and bedding-plane structures normally attributed to turbidite formation, are absent. Thus, transportation and deposition by normal marine currents is most probable in this area.

Depositional Environment

Some indication of the sea-bottom environments that prevailed during the period of deposition of the successive formations may be obtained by consideration of the following data:

(*a*) Composition and preservation of the fossil fauna.

(*b*) Occurrence of carbonate sediments, and the conditions necessary for their formation.

(*c*) Texture and bedding structures of the arenaceous and rudaceous sediments.

(*a*) *Fauna*

As an aid to this and subsequent discussion, the successive Carboniferous marine faunas from all known localities on the Monto 1:250,000 sheet were plotted and a generalized western limit to those of similar age drawn (fig. 6). Complete information on the faunas

DISTRIBUTION OF CARBONIFEROUS FAUNAS, MONTO DISTRICT, QUEENSLAND

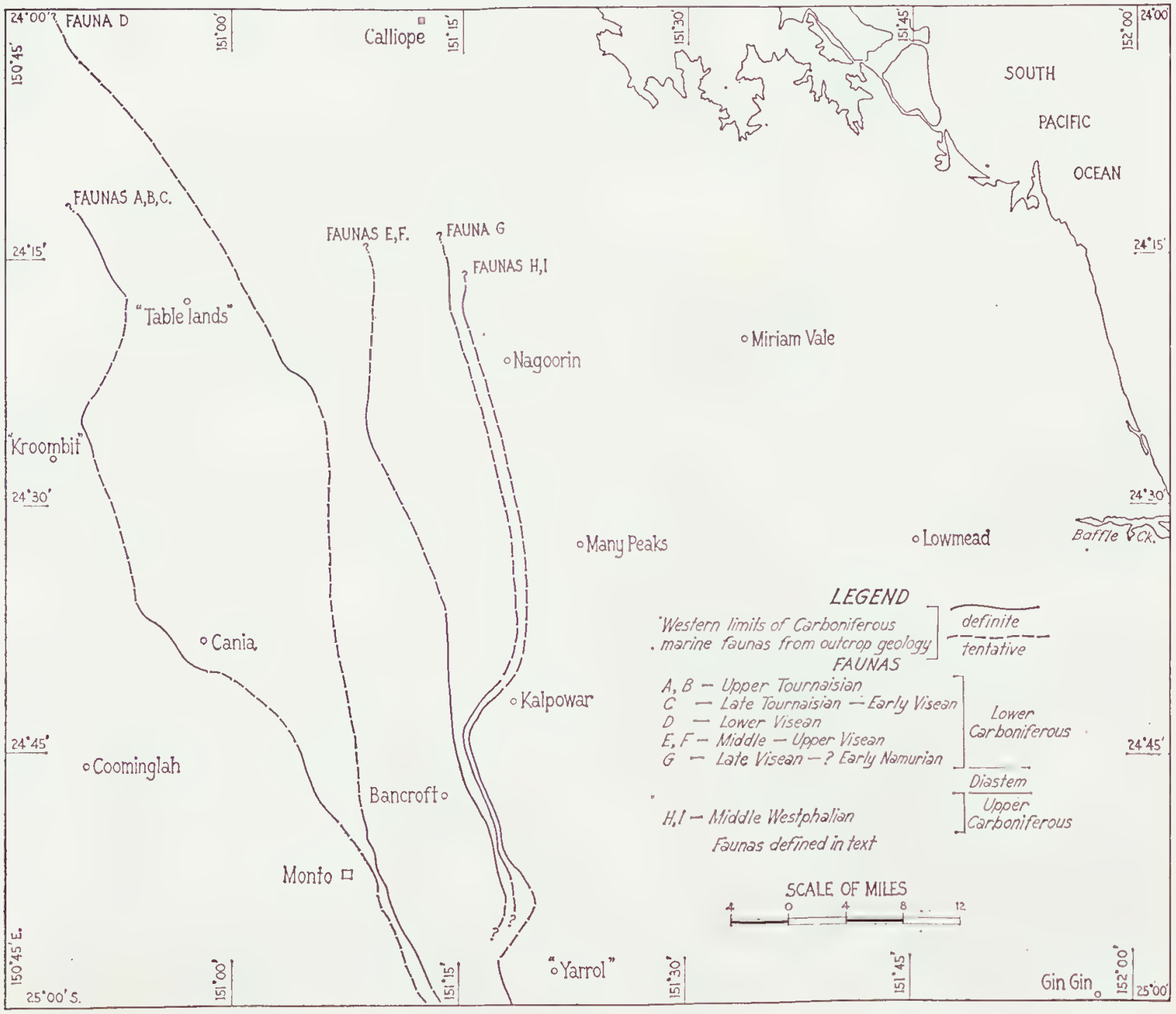


Fig. 6

utilized is available in the section entitled "Biostratigraphy". The resultant generally north-south trending boundaries presumably approximate to the relative positions of the shoreline throughout the Carboniferous; true position can not be accurately assessed due to folding of the strata. It is evident that the sea had maximum extent to the west in Tournaisian time, but that regression with contraction of the depositional area continued very slowly throughout the remainder of the Lower Carboniferous. A considerable disconformity between the Baywulla and Branch Creek Formations (McKellar, 1965) indicates that the regression was completed by late Viséan or early Namurian time, but limited transgression on the eastern fringe of the present structural basin occurred once more in the Westphalian. Shoreline position remained relatively constant during the remainder of the Upper Carboniferous. From the above plot, the suite of faunas (and indirectly, the formations) that might be expected in any area, and their approximate distance from shoreline can be observed quite readily.

Regarding the Cannindah Creek area specifically, prolific faunas that include elements of the Bryozoa, Coelenterata, Brachiopoda, Mollusca, Echinodermata and Arthropoda occur in the upper unit of the Crana Beds and succeeding formations on the western limb of the syncline. Together, they must indicate moderately shallow marine shelf conditions in that area from the upper Tournaisian to the end of the Carboniferous, with the exception of the period of non-deposition in the early Upper Carboniferous. On the eastern limb of the syncline, reduced faunas have been collected from the Dakiel and Baywulla Formations, and normal faunas from the Poperima and Rands Formations. The Branch Creek Formation has an intermediate position with a moderately large, but modified and apparently deeper water facies-fauna. This distribution may mean that the sea was rather too deep in this area for faunal development until middle or upper Viséan time.

Articulation of brachiopods and bivalve molluscs appears to have limited importance as a guide to environment, as both articulated and disarticulated specimens occur at all horizons excepting one in the Baywulla Formation. It is likely that this condition is normal for faunas which have not been transported to any extent. In the upper unit of the Baywulla Formation, brachiopod shells are not only all disarticulated, but they are sorted also for weight and shape, so that brachial and pedicle valves of *Marginirugus* and *Pustula* are only rarely found at the same locality. This is certainly reasonable argument for very shallow marine conditions with strong wave and current action in the Upper Viséan, before final withdrawal of the sea.

Bank type coral growth occurs in the Splinter Creek Formation (western limb); no true reefal development occurs, only plentiful but scattered growth of solitary and compound coralla in similar proportions. If it could be assumed that banks of rugose corals, like modern scleractinians, were restricted to clear, relatively shallow, warm water of the neritic zone, then this would provide an excellent indication of environment. The lack of the complex, resistant coral framework of the near surface reef suggests development in water below normal wave base. Numerous solitary *Amygdalophyllum* have been collected from limestone in unit B, Dakiel Formation, and most have abraded exteriors. This is attributed to active wave rolling in shallow, turbulent water. Filamentous algal structures including *Girvanella*-like forms occur in muddy limestone of the uppermost Splinter Creek Formation, and as oolite nuclei in the lower part of the Dakiel Formation. That these sediments were laid in water sufficiently shallow to allow photo-synthesis to take place, is beyond doubt.

(b) *Carbonate Sediments*

Lutaceous limestones occur as large lenticular deposits in the Crana Beds (1,300 feet below top) and about the middle of the Bancroft Formation. Other occurrences in the Kolonga Creek Limestone (Splinter Creek Formation) and Baywulla Formation grade laterally to oolitic limestones. As gradation occurs in the upper limestones two possible modes of formation present themselves:

(i) accumulation of lime mud outwash away from the provinces of active precipitation and oolite formation.

(ii) formation by direct precipitation, as with oolites, but deposition below wave base where oolites could not be formed.

Thus, the occurrence of pure lutites in the early formations possibly reflects accumulation in quiet offshore waters, as might be expected from the regional distribution of faunas (fig. 6). The occurrence of pyrite segregations in the limestone of the Crana Beds may be regarded as indicative of mildly reducing conditions, and poor circulation on the sea bottom at that time.

On the western limb of the syncline oolitic limestone development is quite characteristic of the Caswell Creek Group and occurs at many horizons; however, on the eastern limb it is known from only two beds. The conditions for oolite formation are believed to be quite specific. A partially restricted, warm, shallow, wave agitated marine environment, through which colder, carbonate saturated currents may freely pass is required. Carbonate solubility decreases as the water is warmed and precipitation will take place on nuclei, about which the carbonate will build in concentric layers. The ultimate size of the oolite relates to wave strength in the province of formation (Carozzi, 1959). The value of oolites as an indicator of environment is limited a little by the knowledge that currents will sweep a certain amount of the oolites from the formational area, and they will behave similarly to other arenaceous sediments. Such redistributed oolites are unlikely to form pure limestone deposits far from their source; observations suggest that admixture with terrigenous sand and deposition in calcareous subgraywacke units is the

normal occurrence. On the eastern limb of the syncline, a partly oolitic spergenite occurs in unit B of the Dakiel Formation, and a relatively large, fairly pure oolitic limestone in the Baywulla Formation. The absence of older oolitic limestones supports the view that the area was away from the shore in rather deep water until well into Viséan time.

(c) *Texture and Bedding of Arenites and Rudites*

The occurrence of coarse-grained arenites and rudites in the succession above the base of the Splinter Creek Formation on the western limb of the syncline, and to an extent, above the base of the Dakiel Formation on the eastern limb, must indicate high current velocities at their time of deposition. Most of the arenaceous sediments, including oolitic limestones, are simply bedded; large scale cross-bedding is not frequently seen, perhaps due to inadequate outcrop. Cross-bedding has been observed in arenites of the upper Splinter Creek, Dakiel, Baywulla, Branch Creek and Rands Formations. Its presence provides further evidence for rather strong current activity in the environment of deposition of such units.

Lithification

In the Lower and Upper Carboniferous rocks the pattern of cementation, which is probably both a diagenetic and post-diagenetic process, is essentially constant. The grey and light brown arenites and rudites of the Bancroft, lower Dakiel, Branch Creek and Rands Formations have an abundance of acidic volcanic detritus among their components. In these, the earliest cement is silica which appears as microcrystalline aggregates at grain contacts. Slight pressure solution at contacts of siliceous grains with adjacent redeposition may well be the process operating. Grain suturing is never very marked. Later pore fillings are of calcite, chlorite, or both. The dark green and red-brown arenites and rudites so common in the Lower Carboniferous formations have andesite and other intermediate lava fragments predominant among their constituents. Their primary cement is frequently chlorite; secondary cements are calcite, zeolite and epidote, and they are almost invariably present. These cements, like the secondary cements of the light coloured rocks, could have been derived by chemical breakdown of lava fragments in situ. Another possibility is that chlorite may be formed by re-organization of an original clay fraction as an authigenic process. Carbonate may have been leached from organic material and redeposited in the grain interstices.

Recrystallization is always marked in lutaceous limestones, and oolitic limestone and subgraywacke with calcite matrices. When present in oolites the process often has extended outward in long "fingers" from organic calcite nuclei. The limonite coatings of pebbles in some conglomerate beds low in unit C, Branch Creek Formation, may have resulted from original deposition as oxides or carbonates in a shallow, subaerial environment, or simply from ground water oxidation of interstitial chlorite in the weathering process. Limestones, sandstones, and conglomerates throughout the entire Carboniferous succession are all without recognizable porosity in surface samples. Porosity may improve at depth below the zone of ground water activity; however, from the present observations these rocks seem to have little promise as reservoirs for water or hydrocarbons.

Basin Shape

The best guide to the position and orientation of the shoreline during the Carboniferous is that obtained from the regional distribution plot of faunas (fig. 6). As the regression in the Lower Carboniferous occurred toward the east, this must have been the direction of increasing water depth at any particular time. The coastline was almost meridional—surprisingly similar in trend to that at the present time.

As the Dakiel, Baywulla and Branch Creek Formations occur on both limbs of the syncline well away from the axial area, they each have outcrop representative of areas that were fairly widely separated on the original sea bed. Size and composition of their faunas might be expected to change from west to east across the fold if the above proposition of deepening water toward the east is reasonable; in point of fact, it does. On the western limb, the Dakiel Formation is certainly the most fossiliferous in the sequence, with prolific brachiopod and molluscan faunas at many horizons and localities. On the eastern limb only two fossil localities have been found (in unit B) and the fauna represents only a very small proportion of the known species. The Baywulla Formation is not very richly fossiliferous in the map area, but there is again reduction from four brachiopod species at numerous localities on the western limb, to two from two localities on the eastern limb. A relatively large, but most unusual fauna occurs in the Branch Creek Formation on the eastern limb. Those species common to faunas on each limb have shells of reduced size with less thickening and more pronounced ornamentation in the eastern collections. As previously mentioned, the eastern fauna was interpreted as a deeper water facies variant of the "normal" western limb fauna by the writer (McKellar, 1965).

Facies change in the sediments from west to east across the basin also provides very definite support for the above interpretations. In the upper unit of the Crana Beds and the Bancroft Formation, mudstone is the dominant lithology. The Cania Formation (Dear, 1967) at the western margin of the basin was deposited simultaneously, but in that environment subgraywacke and conglomerate were the prevalent lithologies. If the Cannindah Limestone (1,500+ ft.) is at least partially equivalent to the Kolonga Creek Limestone Member (20–120 ft.) of the Splinter Creek Formation, then the oolite beds and reef core of the former either wedge out, or progressively interfinger with argillaceous and (?) arenaceous terrigenous sediments across the Tellebang Anticline toward the east. Unit D of the Splinter Creek Formation has subgraywacke, oolitic limestone, and conglomerate composing

half its thickness on the western limb of the syncline, but on the eastern limb oolitic limestone is absent, and a monotonous sequence of dark indurated mudstone and fine subgraywacke prevails.

The New Cannindah Conglomerate Member of the Dakiel Formation persists across the syncline but the grade of rudaceous material is reduced on the eastern limb. Units B and C of the formation have much coarse subgraywacke, oolitic and detrital limestone and granule conglomerate on the western limb. In the east the units comprise a thick sequence of indurated mudstone and fine subgraywacke; coarse subgraywacke beds are infrequent, and partly oolitic limestone occurs in a single thin bed 600 feet above the conglomerate member.

The thick oolitic limestone of unit A, Baywulla Formation, is persistent across the syncline, but units B and C of coarse subgraywacke, conglomerate and oolitic limestone on the western limb again give place to fine and medium-grained subgraywacke and mudstone in the east. Facies change in the Branch Creek Formation was discussed by the writer (McKellar, op. cit.). Coarse and medium-grained subgraywacke with conglomerate at numerous horizons is typical on the western limb; fine and medium-grained subgraywacke with a reduced conglomerate at one horizon occurs on the eastern limb.

An eastern margin to the basin is not postulated, as there is no evidence of a sedimentary source to the east of the depositional area at any time in the Carboniferous. Much of the cleaved undifferentiated Palaeozoic strata to the east of the Yarrol fault eventually may be proved to be Carboniferous in age, but strata of ? Silurian, Devonian and Permian age can be expected in addition as marine seas probably submerged the area during these periods. Fracture cleaved, coarse oolitic subgraywacke that must have its place in the Caswell Creek Group has been identified from such strata two miles east of the Yarrol Fault near Kalpowar. The area in question was mapped as undifferentiated Palaeozoic, Kolan River Beds on the Monto 1:250,000 geological sheet.

Controls for Carboniferous Sedimentation

One of the most impressive features of the Yarrol Basin is the enormous thickness of sediment deposited during the Carboniferous alone. In the map area some 15,600 feet, or three miles, are documented, and even then no thickness could be advanced for the greater part of the Crana Beds, and the Rands Formation is truncated at the syncline axis. For such thickness to accumulate basin subsidence must have been relatively rapid and very widespread. In addition, faunal distribution (fig. 6) shows that gradual regression toward the east continued throughout the Lower Carboniferous, and to present knowledge, was complete in late Viséan or earliest Namurian time. Transgression occurred again in the Upper Carboniferous (middle Westphalian) and marine sedimentation continued until at least the end of the Carboniferous and probably the early Permian (lower Artinskian). Consequently, during the Lower Carboniferous, subsidence is evident from sedimentary thickness, but at the same time seas were retreating from the area. In this context, epeirogenic uplift as a cause for the regression seems unlikely. Maxwell (1964, p. 7) suggested eustatism as the control for variation in sediment type; perhaps this can be extended to the overall control for the regression and subsequent transgression of which he was unaware.

The sequence of lithologies in the Lower Carboniferous is somewhat cyclic. The generalized succession: polymictic pebble and cobble conglomerate, overlain by coarse and medium-grained subgraywacke and oolitic limestone, and ultimately mudstone with some subgraywacke and spergenite, is repeated a number of times. The very immature arenites and rudites may follow, or coincide with, periods of more active regression, thus effectively rejuvenating the source area; similarly, terrigenous lutites could reflect periods of minimum regression or stability, and more prolonged deeper weathering of the source terrain. Vulcanicity was particularly active throughout the Upper Devonian and early Carboniferous in the Kroombit-Cania area, and volcanic outbursts may also have an important place among controls. If intense vulcanicity occurred at certain times on a regional scale, that is, over much of the length of the Yarrol Basin, it could provide an alternative explanation for the cyclic pattern of sedimentation. The major sandstone-conglomerate masses could be related to periods of eruption with consequent formation of unstable land forms. Periods of quiesence would allow the development of mature landscapes, and lutites would be the main product of deeper chemical weathering of the volcanic rocks.

The province of oolite formation appears to have occupied a moderately broad zone flanking the shoreline during most of the upper Tournaisian and Viséan. As the main oolitic limestones accompany units of coarse clastic sediment, it might be suggested, following on the above, that they developed at times of minimum sea level, or of volcanic inactivity.

BIOSTRATIGRAPHY

FAUNAL SEQUENCE

Several phyla are present at most localities in the Cannindah Creek area, but the brachiopods are by far the most abundant, considering both the number of species and individuals. For this reason, they have greatest value in age determination and correlation of the containing formations. Exceptions occur in the Splinter Creek Formation where correlation must rest on the coral faunas, and in the Rands Formation where the few brachiopods are long ranging, and the molluscan faunas have most value.

Mostly, the faunas occur at horizons separated by hundreds of feet of sediment. Thus, it is not surprising that each comprises a rather distinct assemblage which often has little in common with those at horizons above and below. In this situation, a system of assemblage zones, unless extremely broadly conceived, would have very limited value, and several zones would

come to coincide with faunal beds. In Queensland, zonal systems for the Carboniferous rocks in the Mt. Morgan and "Yarrol" regions, have been indicated, but not defined, by Maxwell (1953; 1960a); they will be referred to later in this section. The sequence of organisms in the Cannindah Creek area is defined in terms of *faunas*; some include closely allied assemblages from two or three horizons, and so are analogous to assemblage zones, except that no precise stratigraphic connotation is intended. The ages suggested for the successive faunas will be based very largely on their correlation with closely similar faunas that have been described from New South Wales. It would be inadvisable to attempt independent determination of age until our faunas have been described and their affinities fully investigated. The sequence of faunas is documented in the lists provided with formation descriptions, and the occurrence of brachiopod species illustrated in figure 7.

Fauna A

The fauna includes material from the upper unit of the Crana Beds, and has been collected from the lutaceous limestone and fine subgraywacke beds approximately 1,300 ft. and 50–350 ft. respectively beneath the top of the beds. Characteristic species are *'Avonia'* aff. *kennedyensis* Maxwell, *Ovatia* sp., *Prospira* cf. *typa* Maxwell, *'Dimegelasma' kennedyense* Maxwell and *Cleiothyridina* cf. *segmentata* Roberts. *'Avonia' kennedyensis* is a buxtoniid and appears to have closest affinities to *Protoniella* Bell; the unusual spiriferoid *'Dimegelasma' kennedyense* is tentatively referred to *Adolfia* Gürich (= *Guerichella* Paeckelmann, obj. syn.). The latter species was figured as *Gurichella kennedyense* sic (Maxwell) in Hill and Woods (1964, pl. C9). Certain other very important forms, namely *Rugosochonetes kennedyensis* Maxwell and *Productina globosa* Roberts make their first appearance in the fauna. The age of Fauna A is regarded as Upper Tournaisian if two-fold subdivision of the Tournaisian is accepted, following goniatite zones of Paproth (1960).

Fauna B

The fauna occurs in the Herring Gully Limestone Member at the base of the Bancroft Formation. Most abundant shells are *Martinia productoides* Etheridge and *Brachythyris* cf. *solida* Campbell which occur together in the bed, and appear to be end members of a continuous morphological series. Other diagnostic species are *Delepinea* sp. and *Marginatia* ? sp. Of short-ranged species appearing at this time, the most significant are *Rhipidomella australis* McCoy, *Unispirifer* aff. *striatoconvolutus* (Benson and Dun), *Syringothyris* sp. and *Brachythyris elliptica* Roberts. The distinctive assemblage of Fauna B is believed to reflect the change in life environment with the introduction of arenaceous oolitic sediments, rather than any difference in age. Thus, the Upper Tournaisian aspect of this (?) facies fauna, is not surprising.

Fauna C

The fauna has been collected from the calcareous subgraywacke of unit C, 800–1,000 feet above the base of the Bancroft Formation. Diagnostic species are *Rugosochonetes* sp., a large, rather coarsely costellate form which is prolific in the beds, *Dictyoclostus* sp., *Prospira typa* var. *tellebangensis* Maxwell, *Mucrospirifer* (?) sp. and *Cleiothyridina transversa* Maxwell. The cosmopolitan, but important *Kitakamithyris uniplicata* (Campbell) makes its appearance in the fauna; however, most species are hold-overs from Faunas A and B, and it is significant that they are not known from younger strata. The fauna has late Tournaisian or early Viséan aspect.

Fauna D

This is the predominantly coelenterate fauna of the Kolonga Creek Limestone and unit D of the Splinter Creek Formation. As very little work has been done on the stratigraphy of the Carboniferous corals to date, the importance of the species listed below as diagnostic may be very much over-emphasized. Those restricted to the fauna in the Cannindah Creek area, and along the Yarrol Syncline are *Aulina* aff. *simplex* Hill, *Amygdalophyllum* cf. *etheridgei* Dun and Benson, *A.* cf. *conicum* Hill, (?) *Aphrophyllum hallense* Smith, *gradatus* Campbell, *Pustula abbotti* Campbell, *Eomarginifera paradoxa* (Campbell), *Acuminothyris* cf. *triangularis* Roberts and *Rotaia* (?) sp. *P. abbotti* and *E. paradoxa* are thought to be ancestral to the closely similar species *P.* cf. *gracilis* Campbell and *E. tenuimontis* Roberts respectively, of Fauna F. Fauna E is tentatively dated as middel Viséan.

Fauna E

The fauna occurs in strata of the uppermost Splinter Creek Formation and lower Dakiel Formation, and has a number of valuable guide forms. Among these may be listed *Streptorhynchus* sp., *Echinoconchus gradatus* Campbell, *Pustula abbotti* Campbell, *Eomarginifera paradoxa* (Campbell), *Acuminothyris* cf. *triangularis* Roberts and *Rotaia* (?) sp. *P. abbotti* and *E. paradoxa* are thought to be ancestral to the closely similar species *P.* cf. *gracilis* Campbell and *E. tenuimontis* Roberts respectively, of Fauna F. Fauna E is tentatively dated as middle Viséan.

Fauna F

This is the most prolific brachiopod and molluscan assemblage known in the Carboniferous and is representative of the upper half of the Dakiel Formation.

Characteristic species are *Rhipidomella fortimuscula* Cvancara, *Werriea australis* Campbell, *Schellwienella* (*Pulsia*) sp., *Inflatia elegans* Roberts, *Spirifer lirellus* Cvancara, *Unispirifer* cf. *striatoconvolutus* (Benson and Dun), *Kitakamithyris triseptata* (Campbell), *Brachythyris pseudovalis* Campbell, *Composita* (?) sp., and *Eumetria* (?) *mona* Campbell. There is little doubt that the fauna is indicative of a middle or upper Viséan age.

DISTRIBUTION OF BRACHIOPOD SPECIES IN THE CANNINDAH CREEK AREA

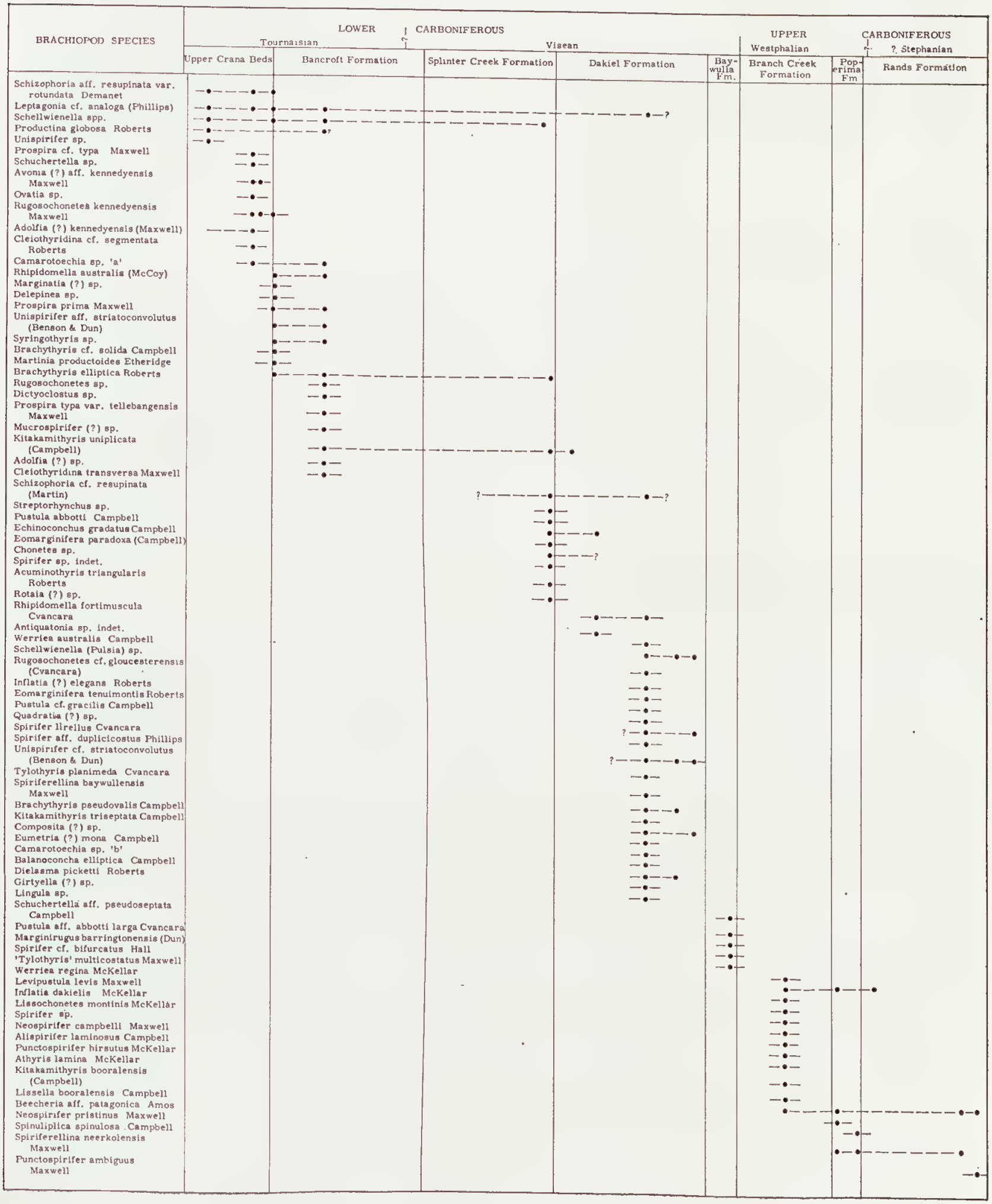


Fig. 7

Fauna G

The fauna was obtained from unit C of the Baywulla Formation. The diagnostic species are *Marginirugus barringtonensis* (Dun) and *Tylothyris* (?) *multicostatus* Maxwell. Although there are no brachiopod species that extend from the Dakiel Formation into the Baywulla Formation in the Cannindah Creek area, *Schuchertella pseudoseptata* Campbell and *Pustula abbotti larga* Cvancara were each described from faunas equivalent to our Fauna F, in New South Wales. The fauna is thought to be of uppermost Viséan or early Namurian age.

Fauna H

Fauna H in unit B of the Branch Creek Formation has no species in common with earlier formations. Some of its very distinctive species are *Werriea regina* McKellar, *Lissochonetes montinis* McKellar, *Inflatia dakielis* McKellar, *Neospirifer campbelli* Maxwell, *Alispirifer laminosus* Campbell, and *Kitakamithyris booralensis* (Campbell). *Levipustula levis* Maxwell and *Beecheria* aff. *patagonica* Amos make their appearance in the fauna and range into the succeeding Poperima and Rands Formations. The fauna has been described in part by the author (McKellar, 1965) and shown to be Upper Carboniferous, probably middle Westphalian, in age.

Fauna I

This is the fauna of the Poperima Formation and has only two truly diagnostic species—*Neospirifer pristinus* Maxwell and *Spinuliplica spinulosa* Campbell. *Levipustula levis* is the most abundant form, but like *Spiriferellina neerkolensis* Maxwell it ranges into the Rands Formation. Fauna I is also presumed to be of Westphalian age.

No attempt has been made to designate faunas in the Rands Formation. The bivalves *Schizodus elliotti* Maxwell and *Limipecten burnettensis* Maxwell are locally quite characteristic of units A and B respectively; the brachiopods *Beecheria* aff. *patagonica* Amos, *Spiriferellina neerkolensis* and *Punctospirifer ambiguus* Maxwell of unit B. The faunas have generally been regarded as Upper Carboniferous (Stephanian) in age (Maxwell, 1964).

CORRELATION OF THE QUEENSLAND CARBONIFEROUS

This discussion attempts to relate the known sections of marine Carboniferous strata in Queensland to that in the Cannindah Creek area. Where there was no published information on the fauna of these sections, collections of the Geological Survey of Queensland and the University of Queensland were drawn on for information.

1. Upper Burdekin Valley, North Queensland

Three main areas of sedimentation, all of which were probably continuous originally, occur in this area to the north of Charters Towers. They are from west to east: the Broken River Embayment, the Clarke River Basin, and the Star Basin (Hill, 1960, p. 7-8).

(a) *Broken River Embayment*

In this embayment of the Tasman Geosyncline, the partially marine Bundock Creek Formation unconformably overlies highly folded Silurian and Devonian formations (Clarke River, 1:250,000 geological sheet). Wyatt and White (1960, p. 180) listed its fauna as *Brachythyris davidis* (Dun), *Avonia kennedyensis* Maxwell, *Crenipecten* sp., and *Allorisma* (?) sp. Mr. J. Jell (University of Queensland) has recently made some collections from the formation and these contain abundant *Pustula multispinata* Roberts, *Retzia* (?) cf. *radialis* Phillips and an unidentified spiriferoid like *Tomiopsis* Benediktova. Thus there is similarity to elements of the upper Tournaisian Faunas A and B in the Cannindah Creek area.

(b) *Clarke River Basin*

The basin is situated over the north-east part of the Clarke River 1:250,000 sheet and north-west part of the adjoining Townsville 1:250,000 sheet. The thin marine Clarke River Formation has a brachiopod fauna of *Schizophoria* aff. *resupinata* (Martin), *Productina globosa* Roberts, *Rugosochonetes* cf. *kennedyensis* Maxwell, *Prospira* sp., and *Brachythyris* cf. *solida* Campbell in the Blue Range area. The fauna is most reasonably correlated with the upper Tournaisian Fauna A in the Cannindah Creek area. Overlying strata in the basin all have a fresh-water origin.

(c) *Star Basin*

The basin is situated almost centrally on the Townsville 1:250,000 sheet area. Marine sedimentation occurred in the Middle Devonian (Givetian) and again from the Upper Devonian (Famennian) into the Lower Carboniferous. Only the youngest strata of the marine Carboniferous succession, that is, the Hardwick Formation, have similar faunas to those in the Cannindah Creek succession. Brachiopods from Corner Creek, a tributary of the Star River include: *Schizophoria* aff. *resupinata* var. *rotundata* Demanet, *Avonia* (?) *kennedyensis* Maxwell, *Rugosochonetes kennedyensis* Maxwell, *Prospira* aff. *typa* Maxwell, *Brachythyris* aff. *solida* Campbell, *Crurithyris* sp., and *Retzia* (?) cf. *radialis* (Phillips). At Mt. St. Michael a comparable fauna from the formation has *Schuchertella* sp., *Avonia* (?) *kennedyensis* Maxwell, *Ovatia* sp., *Rugosochonetes kennedyensis* Maxwell and *Camarotoechia* sp. Both have unmistakable similarity to Fauna A (upper Tournaisian) of the defined succession. Older Star faunas agree most closely with those at Cania, to the north-west of Monto, and consequently are not listed here.

It seems evident that as in the Yarrol Basin and elsewhere, marine transgression was also at its maximum in the upper Tournaisian in this upper Burdekin Valley area. Younger Carboniferous strata were all deposited under freshwater conditions.

2. Yarrol Basin

The basin was defined by Hill (1960, p. 11-12), and its general form delimited also on the Tectonic Map of Australia (1960). Marine Carboniferous sediments are preserved in this narrow structural basin or trough from Proserpine at its northern limit, to the Mundubbera area in the south.

The northernmost strata occur on the Bowen 1:250,000 sheet at Ben Lomond, and to the south-east of it on Ten Mile Creek near its confluence with the Gregory River. The intruded limestone at Ben Lomond has a compound coral identified as an *Aphrophyllum* by Jull (1965 MS), and at the southern locality, what may be the same limestone has the corals *Symplectophyllum* (?) sp. and *Caniniophyllum* sp. associated with the brachiopods *Delepinea* sp. and *Prospira* aff. *typa* Maxwell. Brachiopods collected in mudstone and fine subgraywacke stratigraphically a little below the limestone at the latter locality include *Schizophoria* cf. *resupinata* (Martin), *Werriea* sp., *Avonia* (?) *kennedyensis* Maxwell, *Rugosochonetes kennedyensis* Maxwell, *Prospira* cf. *morganensis* (Maxwell), *P.* cf. *prima* Maxwell, *Retzia* (?) cf. *radialis* (Phillips) and *Crurithyris* sp. The lower fauna compares closely with Fauna A of the upper Crana Beds in the Cannindah Creek area, and also material from Corner Creek (Hardwick Formation) in the Star Basin. The upper fauna is to be compared with Fauna B of the Herring Gully Limestone (Bancroft Formation).

Further south on the Proserpine 1:250,000 sheet, Lower Carboniferous marine fossils were identified from Finlayson's Point near Seaforth by Dear (1963b). Species are *Rhipidomella australis* (McCoy), *Schellwienella* sp., *Rugosochonetes kennedyensis* var. *magnus* Maxwell, *Spirifer* sp., *Prospira* cf. *typa* var. *tellebangensis* Maxwell, *Brachythyris* sp. and *Mucrospirifer* (?) sp. The species *Spirifer* sp. is similar in shape and costation to that figured as *Ectochoristites wattsi* Campbell from the area to the east of Old Cannindah homestead, by Maxwell (1961a, pl. 19). Correlation with the upper Tournaisian or early Viséan Faunas B or C of the Bancroft Formation is suggested. Lower Carboniferous marine strata occur on the Mackay 1:250,000 sheet, and both Lower and Upper Carboniferous on the Port Clinton and St. Lawrence 1:250,000 sheets. Roberts (1963b) identified spiriferids of Upper Devonian or Lower Carboniferous age, and an Upper Carboniferous fauna comprising *Levipustula levis* Maxwell, *Spinuliplica spinulosa* Campbell, *Composita* cf. *magnicarina* Campbell, *Schuchertella* sp., *Rhombopora* (?) *bifurcata* Campbell and *Fistulamina dispersa* Crockford from Long Island in Broad Sound (St. Lawrence 1:250,000 sheet). The collection is similar to the fauna of the lower part of the Neerkol Formation near Rockhampton, and has elements of Faunas H and I of the Cannindah Creek section. Fossiliferous Lower and Upper Carboniferous marine strata are present also to the south of this area on the north-eastern margin of the Duaringa 1:250,000 sheet area about the Craigilee Anticline and extending to the east onto the adjoining Rockhampton 1:250,000 sheet area. Upper Tournaisian brachiopods and Viséan corals have been identified from the 1,700 ft. Lower Carboniferous section (Hill, 1963; Dear, 1963b). The disconformable Upper Carboniferous strata have a fauna much like that listed above from Long Island, but *Alispirifer laminosus* Campbell is also frequently abundant.

Considerable areas of Carboniferous strata outcrop on the Rockhampton 1:250,000 sheet. At Mt. Morgan, Maxwell (1954) described marine faunas of Upper Devonian (Famennian) and Lower Carboniferous age. Material from the five youngest fossiliferous horizons has much in common with that in the Cannindah Creek section. In the Pond Argillites, the faunas of the *Avonia* and Chonetid beds, which are separated by 40–50 feet of unfossiliferous strata, were grouped by Maxwell (1953) in his *Chonetes* Zone. Their combined fauna includes: *'Avonia' kennedyensis* Maxwell, *Rugosochonetes kennedyensis* Maxwell, *'Megachonetes' tenuistriatus* Maxwell, *'Sinospirifer' morganensis* Maxwell, *'Dimegelasma' kennedyensis* Maxwell, *'Brachythyris davidis* (Dun)', and *Camarotoechia* sp. Unlike most chonetoids, *'M.' tenuistriatus* has a convex brachial valve and concave pedicle valve, and should be referred to *Tulcumbella* Campbell whose type, *T. microstriata* Campbell, appears to be its junior synonym. Maxwell (1954), described the species as having concavo-convex shape. *'Sinospirifer' morganensis* is typically more alate than *Prospira typa,* mucronate, and lateral and sinal costae are a little more numerous. Certain specimens in the Geological Survey collections are sufficiently like *P. typa* to suggest that the latter is simply a close evolutionary derivative of *S. morganensis.* The writer would refer the species to *Prospira* Maxwell. Fauna A of the upper Crana Beds appears to be most closely comparable.

The fauna of the *Schizophoria* bed, or "Zone", occurs 850–1,000 feet above the Chonetid bed in the base of the Neil's Creek Clastics. The characteristic brachiopods in the fauna are *Schizophoria* aff. *resupinata* (Martin), *Avonia* (?) cf. *kennedyensis* Maxwell, *'Productus* cf. *minutus* Muir-Wood', *Prospira typa* Maxwell, *P. prima* Maxwell, *Syringothyris australis* Maxwell, *Brachythyris* cf. *davidis* (Dun), *Cleiothyridina australis* Maxwell and *'Phricodothyris lineata* (Martin)', *'Productus* cf. *minutus'* should be referred to *Productina globosa* Roberts, and *'Phricodothyris lineata'* is quite similar to *Kitakamithyris uniplicata* (Campbell). Correlation with Faunas A and B of the Cannindah Creek section is suggested. The fauna is very closely allied to that in mudstone immediately overlying the Herring Gully Limestone in the Degalgil Creek and "Tablelands" areas on the Monto 1:250,000 sheet area.

The *Cleiothyridina* and *Spirifer* beds or "Zones" lie 700 and 1,100 feet respectively, above the *Schizophoria* bed in the Neil's Creek Clastics of the Stony Creek fault block (Maxwell, 1953); however, recalculating thickness from his map information in the Golden

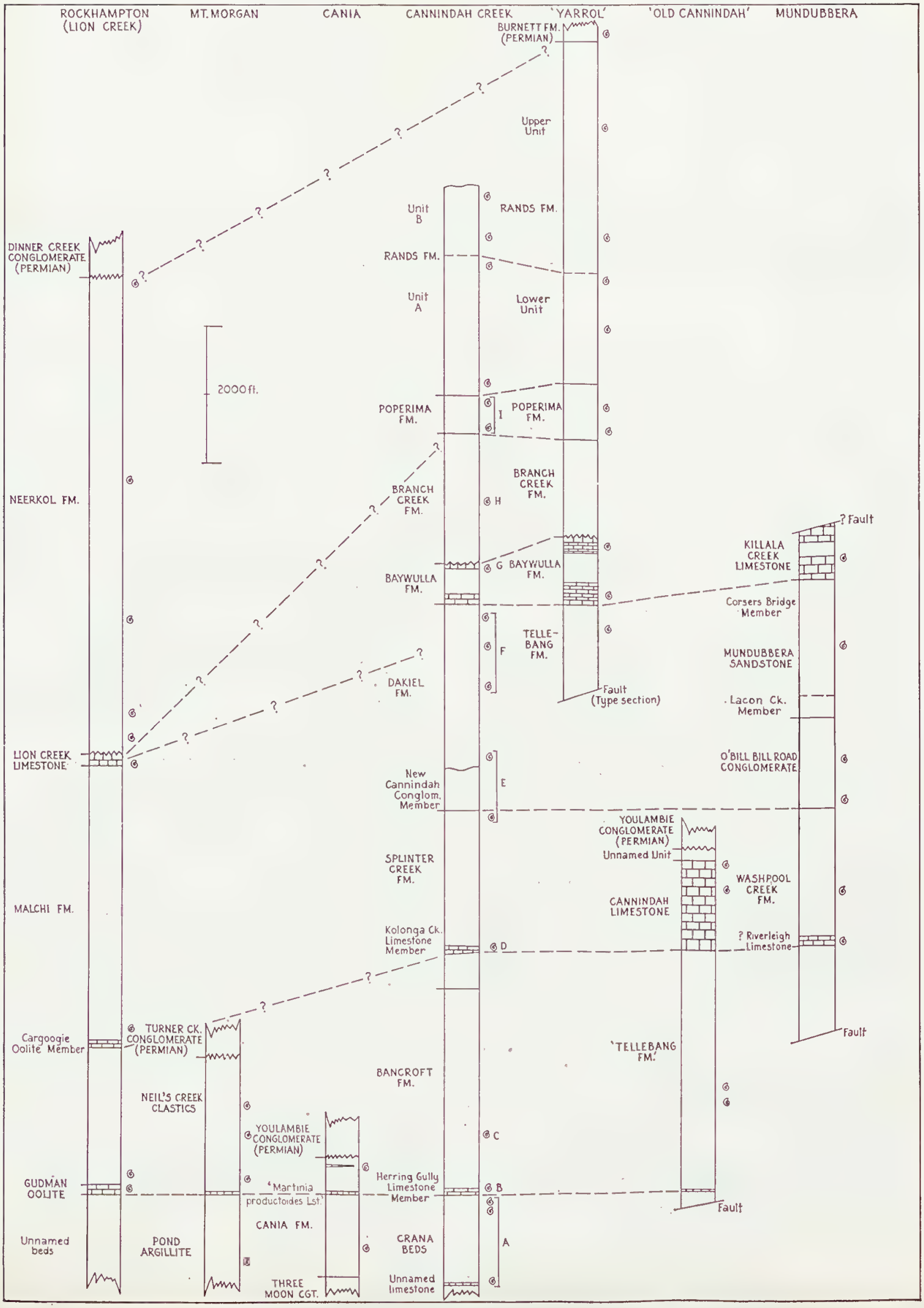

ROCKHAMPTON (LION CREEK)
MT. MORGAN
CANIA
CANNINDAH CREEK
'YARROL'
'OLD CANNINDAH'
MUNDUBBERA
BURNETT FM. (PERMIAN)
Upper Unit
Unit B
RANDS FM.
RANDS FM.
Unit A
Lower Unit
DINNER CREEK CONGLOMERATE (PERMIAN)
2000 ft.
POPERIMA FM.
I
POPERIMA FM.
BRANCH CREEK FM.
BRANCH CREEK FM.
H
NEERKOL FM.
G BAYWULLA FM.
BAYWULLA FM.
? Fault
KILLALA CREEK LIMESTONE
Corsers Bridge Member
MUNDUBBERA SANDSTONE
F
TELLE-BANG FM.
DAKIEL FM.
Fault (Type section)
Lacon Ck. Member
LION CREEK LIMESTONE
O'BILL BILL ROAD CONGLOMERATE
New Cannindah Conglom. Member
E
YOULAMBIE CONGLOMERATE (PERMIAN)
Unnamed Unit
SPLINTER CREEK FM.
WASHPOOL CREEK FM.
MALCHI FM.
CANNINDAH LIMESTONE
Kolonga Ck. Limestone Member
D
? Riverleigh Limestone
Fault
Cargoogie Oolite Member
TURNER CK. CONGLOMERATE (PERMIAN)
'TELLEBANG FM.'
BANCROFT FM.
NEIL'S CREEK CLASTICS
YOULAMBIE CONGLOMERATE (PERMIAN)
C
GUDMAN OOLITE
'Martinia productoides Lst.'
Herring Gully Limestone Member
B
Fault
Unnamed beds
POND ARGILLITE
CANIA FM.
CRANA BEDS
A
THREE MOON CGT.
Unnamed limestone

Fig. 8

Gully fault block, the *Cleiothyridina* and *Spirifer* beds appear to be 250 ft. and 450–500 ft. respectively, above the *Schizophoria* bed. Their combined fauna includes *Rugosochonetes* sp., *R. kennedyensis* var. *magnus* Maxwell, *Spirifer* cf. *liangchowensis* Chao, *Brachythyris* cf. *pinguis* (Sowerby), *Cleiothyridina transversa* Maxwell, *Cleiothyridina biconvexa* Maxwell, *Syringothyris australis* Maxwell and *'Phricodothyris lineata* (Martin)'. It is most similar to the late Tournaisian-early Viséan Fauna C of the Bancroft Formation, although it is conceivable that the "Zones" are as young as the upper part of the Bancroft Formation. The Neil's Creek Clastics are disconformably overlain by the Turner Creek Conglomerate of Permian age (A. G. Kirkegaard pers. comm.).

In the Malchi Creek area several miles to the north-east of the Mt. Morgan fault blocks, and separated from them by a large north-east trending fault, the sequence is much more complete. Fleming (1967) has subdivided the Lower Carboniferous Rockhampton Group, which has a total thickness of 6,000 feet, into three formations: the Gudman Oolite, Malchi Formation with its Cargoogie Oolite Member and Lion Creek Limestone. The "Fairy Bower" fauna from mudstone overlying the Gudman Oolite in the base of the Malchi Formation is almost totally equivalent to that of the *Schizophoria* bed at Mt. Morgan. Species include the brachiopods *Rhipidomella australis* (McCoy), *Productina globosa* Roberts, *Prospira* cf. *typa* Maxwell, *Brachythyris* aff. *solida* Campbell, and goniatites *'Pseudarietites'* sp. and *Protocanites* sp. Few brachiopods are known in the upper formations. *Delepinea* sp. and *Unispirifer* cf. *striatoconvolutus* (Benson and Dun) have been collected by Fleming from the Malchi Formation above its oolite member and may relate these beds to the Dakiel Formation in the Cannindah Creek area, and O'Bil Bil Road Conglomerate or Mundubbera Sandstone about Mundubbera. On its superposition, the Lion Creek Limestone is presumed to correlate with strata in the upper part of the Dakiel Formation or Baywulla Formation. Its coral fauna does not appear to be sufficiently distinctive to place it precisely within the Viséan sequence. The Upper Carboniferous Neerkol Formation disconformably overlies the Rockhampton Group and it is estimated by Fleming (1967) to be 7,000 feet thick. Brachiopod faunas from 150 feet above its base include *Streptorhynchus* sp., *Levipustula levis* Maxwell, *Neospirifer pristinus* Maxwell, *Spiriferellina neerkolensis* Maxwell and *Beecheria* aff. *patagonica* Amos. They resemble species in Fauna I of the Poperima Formation in the Monto district. *Levipustula levis* has a long range and occurs in association with *Limipecten burnettensis* Maxwell and *Phestia* cf. *etheridgei* (Maxwell), approximately 2,000 feet above the base of the formation. The molluscs occur together near the top of unit A, Rands Formation in the "Yarrol" region.

To the south-east of Rockhampton near Mt. Larcom, Jell (1961 MS) mapped and described sediments of the Lower and Upper Carboniferous. He related an oolitic limestone at the top of the Lower Carboniferous sequence to the Lion Creek Limestone on its coral fauna. In the Upper Carboniferous sequence, lower arenites contain the bryozoa *Fistulamina dispersa* Crockford and *Evactinopora* (?) sp.; overlying mudstone and siltstone, *Alispirifer laminosus* Campbell and *Levipustula levis* Maxwell. The faunas are most similar to those of Fauna H of the Branch Creek Formation, but may be as young as Fauna I of the Poperima Formation in the Cannindah Creek section.

On the Monto 1:250,000 sheet area there is very considerable similarity in the faunas of a given age over most of the basin. It is noteworthy that the same general horizons are fossiliferous everywhere, irrespective of lithology, and intervening strata are nearly always barren.

Dr. J. F. Dear is currently describing the stratigraphy and listing faunas from Cania to the north-west of Monto, on the western margin of the Yarrol Basin. In that area the Famennian Dawes Range Formation is overlain by the lower Tournaisian Three Moon Conglomerate, and upper Tournaisian Cania Formation. The Permian Youlambie Conglomerate disconformably overlies these older rocks. The lower arenite-rudite unit of the Crana Beds in the area to the east of Monto is probably equivalent to the Three Moon Conglomerate and perhaps the uppermost part of the Dawes Range Formation; however, as there are no marine fossils other than some moulds of solitary corals in the lower Crana Beds, the relationship remains unproven. Two faunas have been distinguished in the Cania Formation by Dr. Dear. That from the interval above, and including the *'Martinia productoides* Limestone' has *Rhipidomella australis* (McCoy), *Prospira* cf. *typa* var. *tellebangensis* Maxwell, *P. prima* Maxwell, *Unispirifer* aff. *striatoconvolutus* (Benson and Dun), *Martinia productoides* Etheridge, *Brachythyris solida* Campbell, *Mucrospirifer* (?) sp. or *Tylothyris* (?) sp., and *Cleiothyridina transversa* Maxwell. It is to be correlated with Faunas B and C (upper Tournaisian-earliest Viséan) of the Cannindah Creek area. The fauna from beneath the *'M. productoides* Limestone' is most similar to Fauna A of the upper Crana Beds. Species in common are *Schellwienella* sp., *Schuchertella* sp., *Rugosochonetes kennedyensis* Maxwell, *Prospira prima* Maxwell and *Brachythyris* aff. *solida* Campbell.

In the "Yarrol" area, the stratigraphically lowest described formation is the Tellebang Formation (Maxwell, 1960a). As mentioned previously, its type section is faulted and strata bearing *Leptophloeum australe* (McCoy) to the west of the fault are brought into juxtaposition with beds containing *Eomarginifera* cf. *paradoxa* (Campbell), *Pustula* cf. *abbotti* Campbell, *Unispirifer* cf. *striatoconvolutus* (Benson and Dun) *Spiriferellina baywullensis* Maxwell and *Balanoconcha elliptica* Campbell. The plant *L. australe* occurs in the lower and early upper units of the Crana Beds; the marine fauna, which relates to Fauna F, occurs in the upper part of the Dakiel Formation in the Cannindah Creek area. Thus the upper Tournaisian and lower Viséan sequence has been lost in the type

section. As might be expected, faunas of the overlying Baywulla, Branch Creek, Poperima and Rands Formations agree very closely with those in their northern extension. It should be mentioned that the fauna of the Baywulla Formation listed by Maxwell (1959, 1960a) not only includes brachiopods from the formation in the "Yarrol" region, but also corals from the Cannindah Limestone at "Old Cannindah".

In the "Old Cannindah" area to the west of the "Yarrol" area on the western limb of the Tellebang Anticline, the Cannindah Limestone and underlying sediments have been equated with the Baywulla and Tellebang Formations respectively, by Maxwell (1960a, 1961a, 1964). Maxwell (1961a) described the fauna of strata approximately 2,000 feet beneath the Cannindah Limestone in the area immediately to the east of Splinter Creek on Old Cannindah station. It comprises the brachiopods *Schizophoria* sp. indet., *Rugosochonetes kennedyensis* var. *magnus* Maxwell, *Prospira typa* var. *tellebangensis* Maxwell, *P. burnettensis* Maxwell, (?) *Ectochoristites wattsi* Campbell, *Martinia neoproductoides* Maxwell, *Brachythyris* cf. *davidi* (Dun), and *Kitakamithyris uniplicata* (Campbell). *Prospira burnettensis* is very closely allied to *P. prima* Maxwell, and might be regarded as a variety of it. The fauna is most similar to Fauna C of the Bancroft Formation, which is also regarded as late Tournaisian or earliest Viséan in age. Maxwell (1961a, p. 82) related the fauna to those of the *Chonetes* and *Schizophoria* "Zones" at Mt. Morgan, but they appear to be somewhat older.

The brachiopod fauna obtained from the top of the Cannindah Limestone is rather limited, and includes only *Schizophoria* cf. *resupinata* (Martin), *Delepinea cannindahensis* (Maxwell), *Syringothyris* sp. indet., *Martinia* (?) sp., *Kitakamithyris globosa* Maxwell and *Camarotoechia* sp. The prolific coral fauna was described recently by Jull (1965 MS), and has many species in common with Fauna D of the Splinter Creek Formation (Kolonga Creek Limestone, and unit D). As the brachiopod faunas of the Cannindah Limestone and Baywulla Formation are mutually exclusive, it is most unlikely that they are equivalent, particularly when both occur in a very similar sedimentary facies. At the present time correlation with the lower Viséan Splinter Creek Formation seems most acceptable, and is supported by the close stratigraphic relationship of the Cannindah Limestone and strata that are equivalent to the Bancroft Formation to the east of "Old Cannindah". The above correlation was suggested previously by the author (McKellar, 1961 MS). In Flood Creek to the north of "Old Cannindah", 100–200 feet of pink tuffaceous rocks overlie the Cannindah Limestone, and are in turn overlain by coarse, often pebbly subgraywacke of the Lower Permian Youlambie Conglomerate. Although the tuffaceous beds are unfossiliferous, they are regarded as part of the Carboniferous sequence and the obvious disconformity is placed at their upper limit.

The geology of the Mundubbera district (Mundubbera 1:250,000 sheet) was discussed by Driscoll (1960). On the western limb of the Mundubbera Syncline, the sequence of formations indicated by him was: Washpool Creek Formation, O'Bil Bil Road Conglomerate, Mundubbera Sandstone, Killala Creek Limestone and Spectre Creek Beds. The Riverleigh Limestone is contained in the Latza fault block which is bounded by the Washpool Creek Formation. The limestone has a large coral fauna (Hill, 1934) of which *Symplectophyllum mutatum* Hill, *Amygdalophyllum inopinatum* Etheridge, *A. conicum* Hill, *Aphrophyllum foliaceum* Hill, *Carcinophyllum patellum* Hill, *Lithostrotion* cf. *stanvellense* Etheridge and *Aulina simplex* Hill also occur in the Viséan Fauna D of the Splinter Creek Formation. The writer would suggest placement of the Riverleigh Limestone with the Washpool Creek Formation which occupies a position similar to the Splinter Creek Formation in the stratigraphic succession.

Driscoll identified *'Daviesiella'* cf. *aspinosa* (Dun), *Rhipidomella* sp., and some gastropods from the O'Bil Bil Road Conglomerate. The brachiopods are too fragmentary for definite identification, and so have little value in correlation. A lithological correlation of the O'Bil Bil Road Conglomerate and the New Cannindah Conglomerate Member of the Dakiel Formation, was suggested in an earlier section. Brachiopods of the Mundubbera Sandstone (Corsers Bridge Member) include *Rhipidomella fortimuscula* Cvancara and *Brachythyris* cf. *pseudovalis* Campbell which occur in Fauna F of the Dakiel Formation (middle or upper Viséan). The Killala Creek Limestone has *Marginirugus barringtonensis* (Dun), the guide fossil of the late Viséan or earliest Namurian Fauna G of the Baywulla Formation. There appears to be a problem on Driscoll's map, as the Spectre Creek Beds which he presumed to be Namurian in age, have *Leptophloeum australe* (McCoy) in them on the main highway 2 miles north of Mundubbera. *L. australe* is indicative of a late Devonian or early Carboniferous age. Perhaps the boundary of these beds with the Viséan Mundubbera Sandstone and Killala Creek Limestone is structural (faulted?) rather than stratigraphic.

3. Southern Queensland Border Areas

(a) *Mt. Barney*

Maxwell (1960a, p. 167) has indicated that approximately 6,500 feet of marine Carboniferous strata are preserved on the slopes of Mt. Barney, south of Boonah. He suggested that calc-silicate rocks in the basal 300–500 feet may have been Viséan limestones of the type developed throughout the Yarrol Basin to the north. Brachiopods and bryozoa occur in mudstone 2,000 feet above the base and include *Levipustula levis* Maxwell, *Neospirifer* cf. *pristinus* Maxwell, *Spiriferellina neerkolensis* Maxwell, *'Dielasma'* sp., *Fistulamina dispersa* Crockford and *Fenestella* spp. They probably allow correlation with Fauna I of the Poperima Formation in the Cannindah Creek area.

(b) *Texas-Silver Spur Area*

In this area, the Lower Carboniferous Beacon Mudstone (Lucas, 1959, 1960) has limestone lenses containing very poorly preserved *Lithostrotion* and *Symplectophyllum*. Insufficient is known of these corals to allow more than very generalized correlation with those of the Caswell Creek Group in the Yarrol Basin.

CORRELATION WITH NEW SOUTH WALES

1. Gunnedah District

Outcrop in this district occurs in and about the Werrie and Belvue Synclines to the east and north-east of Gunnedah respectively. The oldest Carboniferous strata are the Tulcumba Sandstone and its member the Rangari Limestone; their fauna was described by Campbell and Engel (1963). Campbell thought many species were 'hold-overs' from the Upper Devonian, and suggested a Tournaisian (Cu I) age. Species similar to those in Fauna A of the Cannindah Creek area are *Thomasaria* (?) cf. *voiseyi* Roberts* and *Brachythyris solida* Campbell. At Cania they occur with bivalves like those of the Tulcumba Sandstone in the slightly older Three Moon Conglomerate. *Tulcumbella microstriata* Campbell from the Tulcumba Sandstone appears to be a synonym of *'Megachonetes' tenuistriatus* Maxwell from the Pond Argillites at Mt. Morgan. Its association there with ?*Thomasaria* (or ?*Adolfia*) suggests close similarity in the age of these formations. *Productina globosa* Roberts appears in the overlying Namoi Formation some 450 feet above the Tulcumba Sandstone at Swain's Gully. Its appearance there may coincide with that 1,300 feet from the top of the Crana Beds (Fauna A). The fauna from Babbinboon (Campbell, 1957) occurs at the top of the Namoi Formation and contains among its many species *Werriea australis* Campbell, *Kitakamithyris triseptata* (Campbell), *Echinoconchus gradatus* Campbell, *Eomarginifera paradoxa* (Campbell), *Dictyoclostus* (?) *simplex* Campbell, *Tetracamera* cf. *subtrigona* (Meek and Worthen) (=*Rotaia* (?), sp.), *Unispirifer striatoconvolutus* (Benson and Dun), *Brachythyris pseudovalis* Campbell, *Eumetria* (?) *mona* Campbell and *Balanoconcha elliptica* Campbell. The fauna has elements of Faunas E and F of middle or upper Viséan age in the Monto district, and while several species occur in the latter, *Echinoconchus gradatus* and *Rotaia* (?) sp. are known only in Fauna E.

2. Gresford-Dungog District

The oldest marine Carboniferous faunas in the district occur in the Bingleburra Formation, and form the basis of the *Thomasaria* (?) *voiseyi* Zone of Roberts (1965a). Species include *Streptorhynchus spinigera* (McCoy), *Productina globosa* Roberts, *Pustula multispinata* Roberts, *Acuminothyris triangularis* Roberts, *Brachythyris elliptica* Roberts, *Thomasaria* (?) *voiseyi** Roberts and *Cleiothyridina segmentata* Roberts. They allow rather precise correlation with Faunas A and B of the uppermost Crana Beds and Herring Gully Limestone of the Bancroft Formation (upper Tournaisian). The probable lower Viséan *'Schellwienella* cf. *burlingtonensis* Fauna' also occurs in the Bingleburra Formation some 1,200 feet above the described *Thomasaria* ? *voiseyi* fauna, and 850 feet from the top of the formation. In addition to the nominate species, it comprises *Antiquatonia* cf. *insculpta* (Muir-Wood), *Syringothyris* cf. *principalis* North, *'Camarotoechia'* sp. and *Girtyella* sp. *Schellwienella* with acute cardinal extremities similar to *S. burlingtonensis* Weller and *Syringothyris* are known to occur together only in Faunas B and C in the Queensland succession.

Faunas from the Hilldale area (Roberts, 1964a) and the Wiragulla Beds in the Wallarobba Basin (Roberts, 1964b) are very similar to, and have a number of species in common with Faunas E and F of the uppermost Splinter Creek and Dakiel Formations. They are *Werriea australis* Campbell, *Echinoconchus gradatus* Campbell, *Inflatia elegans* Roberts, *Unispirifer striatoconvolutus* (Benson and Dun), *Kitakamithyris triseptata* (Campbell) and *Dielasma picketti* Roberts. Many of the species have not been collected in Queensland: *Streptorhynchus spinigera* (McCoy), *Schuchertella concentrica* Roberts, *Waagenoconcha delicatula* Campbell, *Gigantoproductus tenuirugosus* Roberts, *Fluctuaria campbelli* Roberts, *Voiseyella anterosa* Roberts, *Asyrinxia lata* (McCoy), *Pseudosyrinx exsuperans* (de Koninck) and *Stenoscisma laevis* Roberts. The significance of the distribution is uncertain; it may reflect geographic isolation, or change from a cool to a warm water faunal association.

The fauna from the upper part of the Bingleburra Formation at Trevallyn (Roberts, 1965a) has considerable similarity to the above faunas even though Roberts (1965b) regards it as somewhat older. It has *Eomarginifera tenuimontis* Roberts, *Dielasma picketti* Roberts and *Werriea australis* Campbell, which occur together only in Fauna F of the Yarrol Basin.

3. Gloucester-Barrington District

Faunas from the Lower Carboniferous Burindi Group in this area have been described by Campbell (1956), Cvancara (1958), and Campbell and Roberts (1964). Cvancara described eleven species of brachiopods of which most occur in Fauna F of the upper Dakiel Formation: *Rhipidomella fortimuscula* Cvancara, *Schizophoria verulamensis* Cvancara, *Leptagonia* cf. *analoga* (Phillips), *Pustula abbotti larga* Cvancara, *'Chonetes' gloucesterensis* Cvancara, *'Phricodothyris' campbelli* Cvancara, *Spirifer lirellus* Cvancara, *Tylothyris planimeda* Cvancara. *'P. campbelli'* is quite close to *Kitakamithyris triseptata* (Campbell). The correlation seems assured. *Delepinea gloucesterensis* Campbell and Roberts, a form not yet known in Queensland, has been collected from 150 feet beneath the mudstone containing the above fauna.

* *Thomasaria* (?) *voiseyi* Roberts is very similar to, and possibly synonymous with *'Dimegelasma' kennedyense* Maxwell which is here tentatively referred to *Adolfia* Gürich.

Marginirugus barringtonensis (Dun) occurs in limestone 150 feet above the fossiliferous mudstone, and its presence allows firm correlation with Fauna G of the Baywulla Formation in Queensland.

From the south-west side of the Gloucester Trough, Campbell (1961) has described the marine faunas of the Booral and Isaacs Formations* in the Upper Kuttung Series. The fauna of the Booral Formation is very closely comparable with Fauna H of the Branch Creek Formation with several brachiopods common to each: *Levipustula levis* Maxwell, *Alispirifer laminosus* Campbell, *'Phricodothyris' booralensis* Campbell, and *Lissella booralensis* Campbell. *Spinuliplica spinulosa* Campbell which was also described from the Booral Formation occurs in association with *Alispirifer* and *Lissella* on the Duaringa and Rockhampton 1:250,000 Sheet areas, but about Monto (Monto 1:250,000 Sheet) it is known only in Fauna I of the Poperima Formation. *Syringothyris bifida* Campbell of the overlying Isaacs Formation has not been collected in Queensland.

4. Kempsey District

Campbell (1962) described faunas from two horizons in the glacial Kullatine Series of this area. The lower has the Namurian (early Upper Carboniferous) goniatite *Cravenoceras kullatinensis* Campbell, the upper 2,000 feet stratigraphically above, *Streptorhynchus* sp., *Levipustula levis* Maxwell, *'Neospirifer pristinus* Maxwell', *Spinuliplica spinulosa* Campbell, and *Composita magnicarina* Campbell. The writer has expressed the opinion elsewhere (McKellar, 1965) that the species listed as *N. pristinus* appears to be referable to *N. campbelli* Maxwell. If this is correct, then correlation with Fauna H of the Branch Creek Formation is likely, even though there is general similarity to both Faunas H and I in Queensland. Campbell (1962) correlated the fauna with that of the Booral Formation on the western flank of the Gloucester Trough.

STRUCTURE

REGIONAL STRUCTURAL SETTING

In the Monto district, Devonian, Carboniferous and Permian marine and marginal freshwater sediments of the Yarrol Basin outcrop in a narrow north-north-west trending belt whose width increases towards the north. Its width is 10 miles about Yarrol station in the south, 14 miles in the Bancroft area, and 30 miles in the Many Peaks-Cania section (Monto 1:250,000 geological sheet).

On the western structural margin of the basin, the Upper Palaeozoic sediments are brought into contact with Jurassic freshwater sediments of the Mulgildie Basin by the Mulgildie Fault System. Reid (1927) first delineated the structure and his sections show that bordering the Mulgildie Coalfield, the fault was considered to be of the simple reverse type dipping east. Any re-interpretation of movement must take into account the dislocation of Upper Palaeozoic rocks along its northern extension in the Cania district, the strong hade of the fault "plane" to the east indicated by seismic survey of the area south of Monto (Prakla [Australia] Pty. Ltd., 1963), and the uptilt or drag of Jurassic sediments to a vertical stance on the western flank of the fault. Movements seem likely in the Upper Permian, Upper Triassic, and in the interval Middle Jurassic to Tertiary. This long history of movement on the fault may have some connexion with its location close to the western margin of the Upper Palaeozoic sedimentary basin, in what must have been a hinge area for the unstable shelf.

On the eastern structural margin of the basin, the Upper Palaeozoic strata are brought into juxtaposition with cleaved unfossiliferous rocks of the Kolan River Beds at the Yarrol "Thrust" (Monto 1:250,000 sheet). The Kolan River Beds possibly include rocks of several Palaeozoic systems; however, certain fracture-cleaved arenaceous sediments in them to the east of Kalpowar (G.S.Q. 4179) contain an abundance of intermediate lava fragments and oolites, and so may be equated confidently with portion of the Lower Carboniferous Caswell Creek Group. Extension of the Upper Palaeozoic sedimentary basin to the east of the present structural boundary at the Yarrol Fault now seems to be beyond doubt. The Yarrol Fault extends in a gentle curve from Mundubbera almost due north to Many Peaks, where it meets a major north-north-west trending fault lineament along the Boyne Valley. In the area to the east of Cannindah Creek the fault-line is marked by a high rectilinear scarp. Folded Upper Palaeozoic strata at its western base are separated from massive grey and pink quartzites on the ridgeline by a serpentinite mass, about a chain wide, that occupies the fault-plane. The quartzites immediately east of the fault seem to be brecciated, extensively silicified argillaceous rocks of that structural block. Serpentinite has been observed on the fault to the east of Yarrol station, Cannindah Creek, and Kalpowar respectively, and on the main road between Many Peaks and Builyan. Areas without intrusion occur between Many Peaks and the obscuring Tertiary basalts north-east of Kalpowar. Foliation in the serpentinite is almost vertical in most areas, but a dip of approximately 80°E. is apparent at times. Driscoll (1960, p. 21) considered that at Mundubbera the fault had allowed a "Lower Palaeozoic" quartzite thrust sheet to move from the east over sediments of the Yarrol Basin; he recognized erosion klippes, and

* The Karuah, Booral and Isaacs Formations that were mentioned in text and indicated on a stratigraphic section by Campbell (1961), do not have any prior use in the literature. It was stated that they outcrop in the Booral area, but under the Australian Code on Stratigraphic Nomenclature, the names require validation by the selection of a type section, and provision of information on their thickness and lithology. The stratigraphic succession represented in the three formations is recognizable in the Buladelah area, immediately to the east of Booral, and was described from there as the Crawford Formation by Engel (1962). The basal beds, which are equivalent to the Karuah Formation, contain the Viséan brachiopod *Marginirugus barringtonensis* (Dun).

regarded the fault as a very low-angle structure. Such an attitude is difficult to reconcile with the almost straight surface trace of the fault, and the high foliation dips in the intruded serpentinites, seen elsewhere along it. The history of movement will be discussed later; however, it seems evident from the degree of involvement of both Upper Palaeozoic and Triassic strata that movement occurred on it both in the Upper Permian and Upper Triassic.

East of Monto, compression of the basin sediments has produced two broad, generally meridional folds: the Tellebang Anticline in the west, and the Yarrol Syncline in the east (Maxwell, 1960a). Large thrust, reverse, and normal faults segment the fold structures and cause some local closures. The longitudinally faulted Tellebang Anticline can be recognized from the area to the west of Yarrol station, to the Mungungo area north-north-east of Monto where it finally loses its identity. The Yarrol Syncline (or Trough) has its southern closure in the area to the east of Abercorn (Mundubbera 1:250,000 sheet), and its northern closure about ten miles north of Kalpowar.

CANNINDAH CREEK AREA

1. Folding, Thrust and Reverse Faulting

That part of the Yarrol Syncline (and east limb of the Tellebang Anticline) included in the map area is a broad, fairly simple structure of the concentric type. In the south-eastern part of the area much of the fold is displaced to the west 0·6 miles by a huge fault, presumed on its geometry to be a fairly low-angle thrust. The structure was designated the Tiverton Fault by McKellar (1964, t. fig. 1). A similar thrust immediately south of the map area causes further displacement of the syncline in the "Yarrol" block over three miles to the west toward the Tellebang Anticline (Monto 1:250,000 geological sheet). North of the Tiverton Fault the fold is rather simple and the axis plunges north at 3°–5° with closure occurring in the upper part of the Rands Formation. On the western limb, dips attain a maximum of 80°–85° (to the east), generally localized in and about the Dakiel Formation, before decreasing toward the western anticline. South of the thrust the syncline is disrupted at the axis by normal faults which cause some increased dips. Contrary to the structure of the northern block, the fold here plunges gently south with closure once more in the upper part of the Rands Formation.

The Tiverton Fault has been traced for nearly eight miles. From its point of truncation at the younger Kalpowar Fault it curves to the west, then swings to the south almost parallel to the synclinal axis before being obscured by the Tertiary sediments in the south of the map area. Its continuation east of the Kalpowar Fault has not been located. The fault is considerably wider than indicated on the map, but as detailed mapping was not carried out over its entire length, its trace had to be generalized. One and a half miles south of Cannindah Creek, movement is known to occur on four subparallel fractures marked by lines of intense brecciation, in a fault zone in excess of 1,000 feet in width. Igneous intrusion on the fault is not known. Striations on a large sub-horizonal slickenside in breccia exposed in a cut on the Cannindah Creek road, were observed to plunge due south at 5°–6°. This may be far from representative of the attitude of the fracture, but it is the only real evidence at hand. The series of (?) normal and reverse faults disjointing the south-eastern block bounded by the Tiverton Fault may represent secondary failures developed during its period of presumed mobility. The faults are without dykes and have resulted in repetition and loss of strata between adjacent blocks.

On the eastern limb of the syncline, north of the Tiverton Fault, two north-south trending faults are responsible for considerable loss of strata. They are characterized by zones of contortion and brecciation without dyke intrusion, and are believed to be reverse faults that may have accompanied advanced folding. A very large fault parallel to the Mulgildie Fault on the western limb of the Tellebang Anticline near Monto, brings strata of the lower Crana Beds in the core of the anticline, in contact with the Splinter Creek Formation. It occurs in a similar structural environment to the reverse faults mentioned above and appears to have comparable movement.

2. Normal Faulting and Dyke Intrusion

Some of the largest and most continuous faults in the Monto district—indeed, in the southern part of the Yarrol Basin, are normal (strike) faults. Three such north-north-west trending faults occur on the western limb of the syncline in its outer zone of decreasing dips (effectively, the eastern limb of the Tellebang Anticline), and cause much repetition of strata. The structures which cause the collapse of the eastern limb of the Tellebang Anticline are accompanied by brecciation of competent strata and dyke intrusion. Tangential stresses within the resulting very elongate "slices" of strata are relieved by a series of cross fractures which are also normal faults. These have allowed block tilting, with accompanying swing in strike direction, to occur south-east of Bancroft. Rhyolite dykes occur both in, and about the fault plane of the eastern-most of this series, and dolerite is present along the fracture passing through Bancroft. Dolerite intrusion occurs also in a normal fault obliquely cutting across the axial zone of the syncline to the north of the Tiverton Fault, and in a small mass apparently unrelated to faults on Barney Creek.

The Kalpowar Fault in the north-east of the map area extends from its junction with the Yarrol Fault east of Monto, through Kalpowar to the western margin of the Glassford Granite (Monto 1:250,000 geological sheet). The fault brings Middle Triassic Muncon Volcanics on its eastern side into juxtaposition with the Upper Palaeozoic marine strata that they overlie unconformably elsewhere. The Muncon Volcanics have relatively gentle saxonic folds developed in them close to the fault, but these structures evanesce laterally. The fault is accompanied by extensive brecciation, basalt and dolerite dyke intrusion and is regarded as a normal fault hading to the east. It is

most probable that this fault is approximately synchronous with the normal faults on the western limb of the syncline, as the fault through Bancroft almost certainly is responsible for the rectilinear, down-warped western margin of the Muncon Volcanic sheet in the Pine Mountain area, some miles to the north.

STRUCTURAL EVOLUTION

In the Monto district at large, fairly continuous marine sedimentation accompanied by active subsidence took place from Devonian to Lower Permian (Artinskian) times in the Yarrol Basin. As Middle Triassic Muncon Volcanics unconformably overlie the Upper Palaeozoic sediments, the movements that concluded the marine sedimentation, elevated, and folded these strata, must have occurred in the Upper Permian. Faulting initiated at this time includes reverse faulting on the western limbs of the anticlines (= eastern limbs of synclines), and lower angle thrusting that disrupted the eastern synclinal trough. The earliest movements on the Mulgildie Fault may also have occurred at this time. Amalgamated Petroleum Mulgildie No. 1 and Abercorn No. 1 wells revealed anomalously thick accumulations of Triassic freshwater sediments and lavas (4,800 ft.), and Jurassic strata including coal measures (1,800 ft.) on the western flank of the structure. Thus, Permian movement seems to have been responsible for localization of the Mesozoic Mulgildie Basin. Considering too, that the Yarrol Fault separates a block of cleaved strata, including oolitic sediments lithologically inseparable from those of the Lower Carboniferous Caswell Creek Group, and uncleaved Upper Palaeozoic strata of the Yarrol (Structural) Basin, it becomes likely that the fault also arose at this time of regional compressive stress. From the north-north-westerly direction of fold axes, and reverse faulting on the western limbs of anticlines, compressive stress is judged to have come from an east-north-easterly direction.

Post-tectonic granites intruding folded Palaeozoic rocks, but directly overlain by Muncon Volcanics, were emplaced in the Yarrol Basin between Glassford Creek, west of Many Peaks, and "Galloway Plains" west of Calliope (Monto 1:250,000 geological sheet). The northern of these has yielded an uppermost Permian age (230–240 m.y.), the southern an Upper Permian age 210–220 m.y); both determinations are by the potassium/argon method (A. W. Webb, pers. comm.). Auburn Complex granites to the west of Monto appear to be of similar age.

The next phase of movements involves the Triassic Muncon Volcanics also, faulting and gently folding them particularly in areas where they are not protected by competent granite substrates. Lower Jurassic Precipice Sandstone has not been influenced where it overlies faulted Muncon Volcanics north of Cania, so that the movements can be isolated to the Upper Triassic. All faults have normal movement and apparently collapse anticlinal structures along fractures generally hading toward their axes. The more obvious movements on the Yarrol and Boyne Valley Faults which form the effective eastern margin of the present structural basin also took place at this time. The Yarrol Fault has Muncon Volcanics downthrown on its western side over much of its northern extent. Regarding the Boyne Valley Fault, downwarping, ultimately to the vertical, of the Muncon Volcanics immediately to the east of the fault zone seems indicative of downthrow once more to the east. In the presumed context of regional tension, one must propose normal movements on both faults. It is worthy of mention that the great normal faults bounding the Esk rifted structure and governing sedimentation in the Maryborough Basin (P. L. Ellis, pers. comm.), like the Yarrol Fault, are convergent ultimately in the Boyne Valley Fault. Whether movement occurred on the Mulgildie Fault during the Triassic is problematic; it certainly is probable. This fault-line appears to have had very considerable topographic expression at the end of the Triassic as it defines very effectively the eastern margin of the Lower Jurassic area of sedimentation. The overall phase of movement must relate to post-orogenic relaxation of compression, and introduction of a tensional state.

Last observable movements involve the Jurassic sequence, including the Mulgildie Coal Measures, along the Mulgildie Fault. Deformation of the Jurassic strata indicates relative downthrow of the western block, probably by normal fault movement. Tertiary basalt sheets of the district are not known to directly obscure the fault-line, so the period of movement remains uncertain. An Upper Cretaceous age for the movement is favoured as some instability is evident at this time in this portion of Queensland. To the north in the Rockhampton-Mt. Morgan district, the Lower Cretaceous (Neocomian) Stanwell Coal Measures (Whitehouse, 1947) and the Upper Jurassic or Lower Cretaceous Mt. Morgan fire-clay and sandstone beds (Bartholomai, 1966) were gently tilted, and near Stanwell also faulted, before the extrusion of the Tertiary basalt sheets. To the east and south-east in the Maryborough Basin, the Lower Cretaceous (Aptian) Maryborough Formation and Lower or early Upper Cretaceous Burrum Coal Measures were folded and faulted before the Tertiary lava flows.

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S. G. Reid, Government Printer, Brisbane

GEOLOGICAL MAP
CANNINDAH CREEK AREA

by R.G. Mc Kellar, B.Sc., Research Geologist, 1966

SCALE 1:31,680

Chains 40 0 40 80 160

Yards 0 1000 2000 3000 4000

Drawn at the Drafting Section, Department of Mines, Brisbane, by J.A. Wright

Reference

CAINOZOIC

UNDIFFERENTIATED

- Cza — *Unconsolidated soil, sand, gravel*

TERTIARY

- Tb — *Black olivine basalt*
- Ta — *Red-brown lateritised, quartzose, fine to coarse sandstone and pebble conglomerate*

MESOZOIC

TRIASSIC

- *Dykes and minor intrusives - do: dolerite, r: rhyolite, b: basalt*
- Muncon Volcanics — Ru — *Intermediate lavas and tuff*

PALAEOZOIC

UPPER CARBONIFEROUS

Boiling Creek Group

- Rands Formation — Cur — *Grey and grey-green sub-greywacke, dark grey siltstone, brown mudstone, pebble conglomerate*
- Poperima Formation — Cup — *Brown and green-brown mudstone and shale, black crinoidal limestone*
- Branch Creek Formation — Cub — *Grey and grey-green medium and coarse grained sub-greywacke, polymictic conglomerate, dark grey siltstone, grey detrital limestone*

LOWER CARBONIFEROUS

Caswell Creek Group

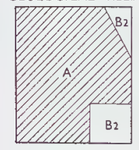
- Baywulla Formation — Cly — *Grey oolitic limestone, fine to coarse grey-green sub-greywacke, polymictic pebble conglomerate*
- Dakiel Formation — Cld — *Dark green coarse calcareous sub-greywacke, brown mudstone, oolitic and detrital limestone*
- New Cannindah Conglomerate Member — Clnc — *Grey and light brown medium and coarse grained feldspathic sub-greywacke, polymictic conglomerate*
- Splinter Creek Formation — Cls — *Dark green and red-brown calcareous sub-greywacke, brown mudstone, oolitic and detrital limestone*
- Kolonga Creek Limestone Member — *Grey oolitic, detrital and lutaceous limestone, brown mudstone*
- Bancroft Formation — Clb — *Brown mudstone, dark grey calcareous feldspathic sub-greywacke, sandy oolitic limestone*
- Herring Gully Limestone Member — *Grey oolitic limestone, brown mudstone*

?UPPER DEVONIAN – LOWER CARBONIFEROUS

- Crana Beds — D-Cc — *Brown mudstone, dark green and brown sub-greywacke, lutaceous limestone; Dark green pebble and granule conglomerate, sub-greywacke, intermediate lava, brown mudstone*
- Undifferentiated — D-Cu — *Brown mudstone, grey and green sub-greywacke, conglomerate*

- *Geological boundary*
- *Fault (⊢ indicates low angle thrust fault)*
- *Synclinal axis*
- *Faulted synclinal axis*
- *Where position of boundaries, faults and folds is approximate, line is broken; where inferred, queried; where concealed, boundaries and axes are dotted, faults are shown as short dashes*
- *Limestone lens*
- *Trend line*
- *Fossil locality*
- *Strike and dip of bedding*
- *Strike of vertical beds*
- A B — *Section line*
- *Road*
- *Railway line*
- *Building*

GEOLOGICAL RELIABILITY DIAGRAM



A: *Detailed traverse*
B2: *Reconnaisance and air-photo interpretation*

Base compiled from 1:25,000 aerial photographs (1958) with partial control

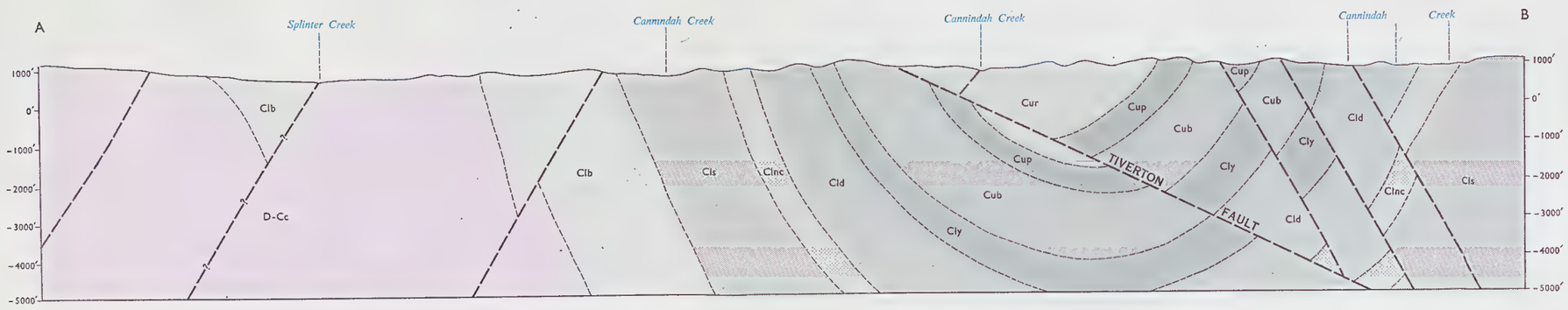
KEY TO 1:250,000 SERIES

Copies of this map may be purchased from the Geological Survey of Queensland, Brisbane

Section A – B

Natural Scale

Cainozoic sediments omitted from section



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QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 332

PALAEONTOLOGICAL PAPERS, No. 2

DEVONIAN MARINE FOSSILS FROM THE SUBSURFACE ADAVALE BASIN QUEENSLAND

PALAEONTOLOGICAL PAPERS, No. 3

ADDITIONAL BRACHIOPODS AND BIVALVES FROM THE ETONVALE FORMATION, ADAVALE BASIN, QUEENSLAND

BY
R. G. McPHERSON, B.Sc. (Hons.)

BRISBANE
By Authority: A. J. Tyrrell, Government Printer
1960

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PALAEONTOLOGICAL PAPERS, No. 4

ADDITIONAL BRACHIOPODS AND BIVALVES FROM THE ETONVALE FORMATION, ADAVALE BASIN, QUEENSLAND

by
R. G. McKELLAR, B.Sc. (Hons)

BRISBANE
By Authority: S. G. Reid, Government Printer
1966

PALAEONTOLOGICAL PAPERS, No. 2

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DEVONIAN MARINE FOSSILS FROM THE SUBSURFACE ADAVALE BASIN, QUEENSLAND

R. G. McKellar, B.Sc. (Hons.)

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

Two species of articulate brachiopods and a bivalve mollusc are described from the lower part of the Etonvale Formation in the recently discovered subsurface Adavale Basin. One of the brachiopods, a small atrypoid with analogues among the Anoplothecidae Schuchert, is regarded as sufficiently distinctive to warrant its separation in a new genus; the name *Neocoelia* is proposed, type species *N. boucoti* sp. nov. The other, a chonetid, is identified only to family. The bivalve is doubtfully associated with *Modiomorpha* Hall, and described as *M* (?) *levisulcata* sp. nov. A Devonian, Emsian or more probable Eifelian age is suggested for the faunule.

INTRODUCTION

In 1962, Phillips Petroleum Company in association with Sunray DX Oil Company drilled Etonvale No. 1 well fifty-eight miles north-north-east of Adavale in south-west Queensland (latitude 25° 09′ 40″ S., longitude 144° 59′ 40″ E.). A thickness of 3,760 ft. of (?) Lower and Middle Devonian strata was encountered above a granite basement which was determined as Upper Silurian in age by the Bureau of Mineral Resources, using the rubidium-strontium method. This sedimentary unit has since been formally designated the Etonvale Formation (Phillips Petroleum Co., 1964), and is now divided into six members, provisionally labelled D1, D2, D3, D4, unnamed shale and basal arkose.

Geophysical work in the Adavale area has delineated a deep basin of moderately folded Devonian and (?) Carboniferous sediments beneath the thick blanket of subhorizontal Permian, Mesozoic and Cainozoic sediments which spreads over this part of Queensland. Boundaries of the basin, which has come to be known as the Adavale Basin following use of this term by Phillips (*op. cit.*), are delimited by unconformities with basement on the east and south, faulting on the west, and a probable depositional margin on the north-west flank. The Etonvale Formation is confined to the southern and eastern parts of the basin (t. fig. 1), where it has been penetrated in a number of other Phillips-Sunray wells: Gumbardo No. 1, Buckabie No. 1, Gilmore Nos. 1 and 2 and Quilberry No. 1. Within this area, the unnamed shale member is known to occur only in the north-east about Etonvale No. 1 and Gilmore No. 1; successive members have greater extent to the north, west and south and are believed to progressively onlap a north-western basement high—the Yaraka Shelf of Heikkila (1966). The nearest outcropping Devonian and Carboniferous strata are in the Drummond Basin, and it has been suggested by Phillips (*op. cit.*) that the Adavale Group, comprising the Etonvale Formation and overlying Upper Devonian—(?) Lower Carboniferous red beds of the Buckabie Formation, was originally continuous with them.

In the lower part of the Etonvale Formation in Etonvale No. 1 well, that is, in the interval 9,615–9,617 ft. (unnamed shale member), a series of shell beds in dark siltstone and shale was found to contain an abundance of a *Coelospira*-like brachiopod, together with a few specimens of a chonetid and three or four species of bivalve molluscs.

The brachiopods are the only articulates known from the well core, and are described in this paper as *Neocoelia boucoti* gen. et sp. nov. and Chonetidae gen. et sp. indet. Of the bivalves, one was identified as *Orthonota,* broadly resembling *O. incerta* Billings and *O. simulans* Billings, by Mr. R. W. Day in an unpublished report of the Geological Survey of Queensland (Day and McKellar, 1962); it is described here as *Modiomorpha* (?) *levisulcata* sp. nov. The others are represented by single or incomplete valves and no attempt has been made to identify them.

The repository for all specimens described or mentioned in the paper is the Geological Survey of Queensland (G.S.Q.).

AGE OF THE FAUNULE

In subsequent discussion of the generic affinities of *Neocoelia boucoti* sp. nov., it will be shown that this little atrypoid is most closely allied to the dayiaceans *Anoplotheca* Sandberger and *Kayseria* Davidson. Certain information pertinent to the age determination may be obtained from this relationship. Firstly, all known genera of the Dayiacea, and more specifically of the Anoplothecidae and Kayseriidae, were extinct by the end of the Eifelian (lower Middle Devonian), so that an upper age limit is in effect fixed. Secondly, regardless of whether *Neocoelia* and *Kayseria* are independent derivatives of the older genus *Anoplotheca,* or whether *Neocoelia* represents an intermediate evolutionary stage, there can be little

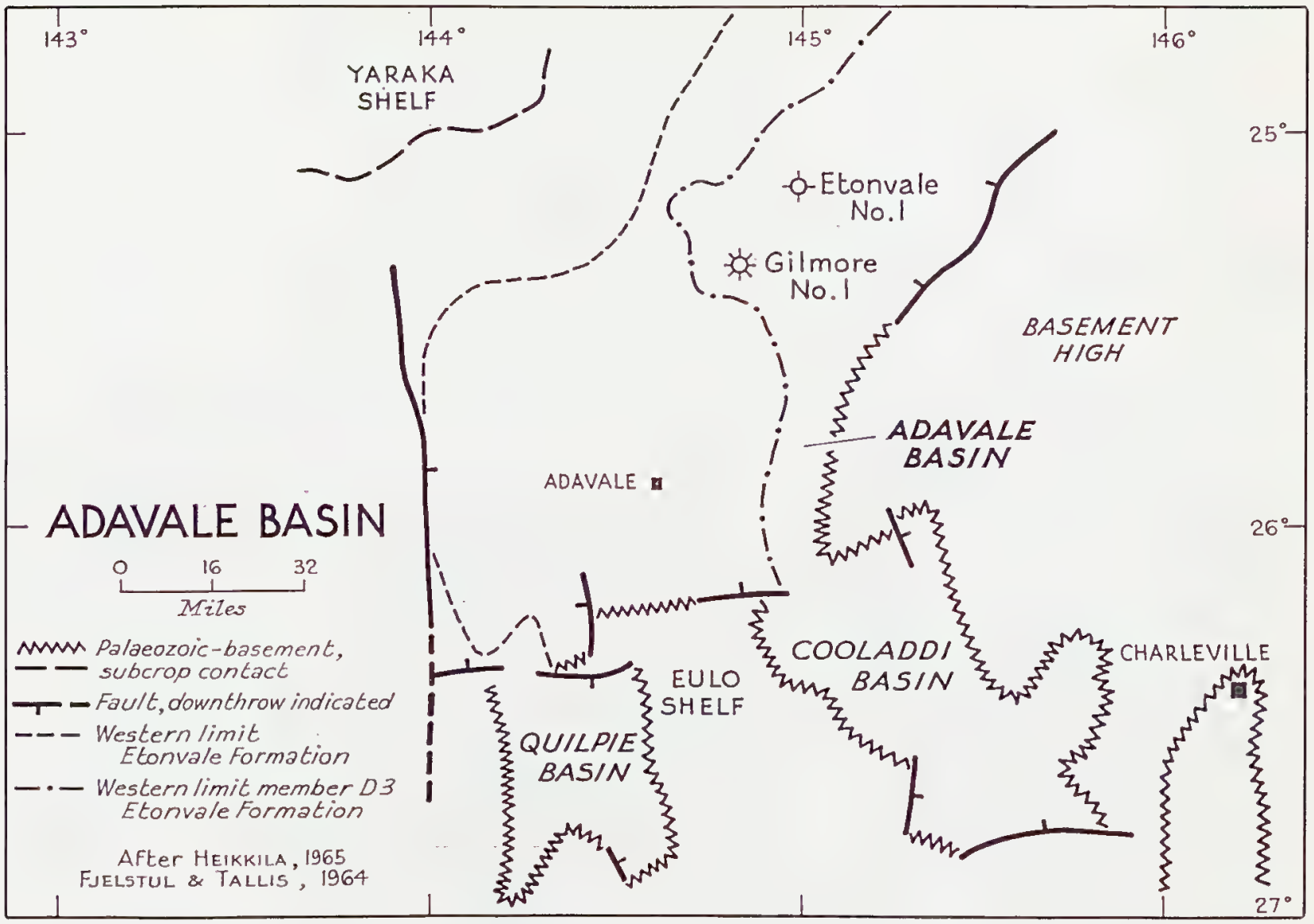

FIG. 1

doubt that this morphologically advanced form will have its place rather late in the history of the group. *Anoplotheca* ranges over the Siegenian and Emsian of the Lower Devonian, and possibly enters the Eifelian; *Kayseria* is known only from the Eifelian (Boucot, Johnson, and Staton, 1964, t. fig. 1). Thus an Emsian, or more probable Eifelian age can be suggested for *Neocoelia*. Present knowledge of the chonetid and bivalve is much too incomplete for them to have any real value for age determination.

Supporting evidence for the proposed age is at best, very tenuous. Tabulate corals have been obtained from Gilmore No. 1 well core at 13,185 feet in a unit which Lewis and Kyranis (1965) correlate with the fossil bearing, unnamed shale member of the Etonvale Formation in Etonvale No. 1 well. They were examined by Professor D. Hill, and in an appendix to the completion report on Gilmore No. 1 well (*op. cit.*) she was able to suggest a Lower or early Middle Devonian age for them.

It should be mentioned also that this Devonian age for the unnamed shale member displaces a late Silurian age, originally suggested in an unpublished report (Day and McKellar, 1962), that has subsequently found its way into the literature (Phillips, 1964; Heikkila, 1966).

SYSTEMATIC DESCRIPTIONS

Phylum	BRACHIOPODA
Suborder	ATRYPOIDEA Moore, 1952
Superfamily	DAYIACEA Waagen, 1883
Family	ANOPLOTHECIDAE Schuchert, 1894
Genus	NEOCOELIA gen. nov.

Type species.—*Neocoelia boucoti* sp. nov., from the lower part of the Etonvale Formation, Phillips-Sunray Etonvale No. 1 well (9,615–9,617 ft.), south-west Queensland.

Diagnosis.—Plano-convex Anoplothecidae with very numerous, fine, low costae, most of which bifurcate; pedicle valve moderately convex, no median fold; brachial valve with broad, extremely shallow median depression. Dental lamellae absent; teeth with deep crural fossettes on postero-medial faces; ventral myophragm, when present, short, fine and very low. Cardinal process small, distinctly bilobate; hinge plates discrete; dorsal myophragm long, broad, and 0·5–0·7mm. high; outer socket ridges strongly developed, crenulate on inner articulating surfaces.

Discussion.—Among plicate dayiaceans, the essentially plano-convex shell shape of *Neocoelia* gen. nov. is characteristic of the Anoplothecidae Schuchert and to an extent, of the Leptocoeliidae Boucot and Gill. In these families, bifurcated plications, analogous to

those of *Neocoelia,* have been recorded previously in only one genus—*Coelospira* Hall. Amos and Boucot (1963, p. 441) used bifurcation of the plications as a basis for the distinction of the anoplothecid subfamily Coelospirinae Hall and Clarke from the Anoplothecinae Schuchert. The biconvex, bisulcate dayiacean *Kayseria* Davidson, sole member of the family Kayseriidae Boucot, Johnson and Staton, has costae that are low and rather fine like those of *Neocoelia,* and are also commonly bifurcated. The genus is separated from the Anoplothecidae primarily because of the development of unusual spiraliferous accessory lamellae that arise from the jugum in its brachidium, and are very similar to those of the Triassic Diplospirellinae Munier-Chalmas with which *Kayseria* was originally grouped by Schuchert, 1894 (Boucot, Johnson, and Staton, 1964, p. 807). The Lower and early Upper Silurian genus *Eocoelia* Nikiforova, presently assigned to the Leptocoeliidae, has numerous, relatively low plications, but they are nearly always undivided and somewhat coarser than those of *Neocoelia.*

In regard to internal structure, all genera of the Anoplothecidae and advanced species of *Eocoelia* have unsupported, elongate hinge teeth incised by crural fossettes on their inner (medial) surface; *Kayseria* too, has teeth of this kind, but I have no information on the presence of fossettes in them. The form of the ventral myophragm is quite variable among these genera. In *Coelospira* it is well developed, wedge-like in section, and in most species extends two-thirds of the valve length. A similar but more bladed myophragm occurs in the derivative genus *Anoplotheca* Sandberger. By contrast, *Eocoelia* and *Neocoelia* invariably lack appreciable development of the structure. *Kayseria* has an unusual, low, broadly rounded myophragm.

The moderately small, distinctly bilobate cardinal process of *Neocoelia* is most like that of *Anoplotheca.* In *Coelospira* it evolves from an early, low, boss-like condition in *C. saffordi* (Foerste) of the Upper Silurian to the typical, low, bilobate form in *C. concava* (Hall) and the related species *C. virginia* Amsden of the Lower Devonian (Helderbergian). The simple form is retained in some specimens of the type species, *C. concava.* In *C. dichotoma* (Hall) higher in the Lower Devonian (upper Deerparkian) further evolution toward a specialized, perhaps more functional attachment site for the diductors has occurred, and the cardinal process is moderately elevated, elongate-oval in outline, and posteriorly quadrilobed. Other anoplothecids, *Kayseria* and *Eocoelia* either lack a cardinal process, or the structure is small, low and knob-like. *Neocoelia* further resembles *Anoplotheca* in its long, broad moderately elevated dorsal myophragm. Some prepared specimens of *Kayseria,* from the Ahbach Folge near Ahütte in the Eifel, that showed most brachial valve structures, were generously loaned to me by Dr. A. J. Boucot (California Institute of Technology). The myophragm in the genus is long, broad and untapered, as in *Anoplotheca* and *Neocoelia,* but much more elevated and septum-like, particularly toward the front; thus the high triangular profile commented on by Davidson (1882, p. 22). Dental sockets in *Neocoelia* are crenulate (corrugated) on their outer faces, smooth on medial faces, and although it has not been observed on the limited material, teeth too may be partly crenulated. Crenulation of teeth and sockets occurs sporadically throughout the Atrypoidea. Among dayiaceans it is relatively unusual and seems to occur only in *Dayia* Davidson, *Leptocoelia* Hall, *Neocoelia* gen. nov., and from the material on hand, *Kayseria* Davidson.

From the relationships outlined above certain conclusions can be drawn. Although the size, plano-convex shape and bifurcated costation of *Neocoelia* are closely similar to *Coelospira dichotoma,* the form of the cardinal process, hinge plates and dorsal myophragm precludes very close relationship. *Anoplotheca* has similar shape, and development of the dorsal cardinalia to *Neocoelia,* but plication is very broad and low, essentially undulose, and the ventral myophragm is well developed. Even though its brachial valve is convex and medially sulcate, *Kayseria* has costation most closely comparable with that of *Neocoelia,* and the dorsal cardinalia, perhaps with the exception of the smaller cardinal process, is also remarkably similar. Thus, despite obvious differences *Neocoelia* does appear to be somewhat intermediate between *Anoplotheca* and *Kayseria,* with shape suggesting closer affinity to the former. The former view was expressed originally by Dr. A. Boucot and his colleague Dr. J. Johnson in correspondence discussing the problem. Such a relationship appears to provide firm support for the removal of *Kayseria* from the Athyridacea (Diplospirellinae) and reassignment to the Dayiacea by Boucot, Johnson, and Staton (1964). Should the alliance of *Neocoelia* and *Anoplotheca* prove to be soundly based it may be difficult to justify the present grouping of anoplothecid genera in subfamilies on the presence or absence of bifurcated costation or plication. Amos and Boucot (1963, p. 443) and Boucot, Johnson, and Staton (1964, t. fig. 1) regard *Eocoelia* as a member of the family Leptocoeliidae and ancestral to *Leptocoelia* and *Australocoelia* Boucot and Gill. Considering its internal structure in particular, I would regard it as more closely allied to *Coelospira,* and so, also the parent genus of the Anoplothecidae, even though it lacks a calcified brachidium. The presence of an extremely robust cardinalia with its specialized "trilobate" cardinal process in *Leptocoelia* and *Australocoelia* suggests that these advanced forms are well removed from the *Eocoelia* stock, although apparently independently evolved from the *Coelospira* line.

Necoelia boucoti sp. nov.

Pl. 1, figs. 1–9

Material.—Holotype F 3696 G.S.Q.; paratypes, F 3687-90, 3693-95, 9537 G.S.Q.; numerous other incomplete valves.

Description.—The shell is small and its outline subcircular, slightly longer than wide; lateral profile is essentially plano-convex.

The pedicle valve umbo is very small and obtuse; no palintrope or interarea is developed. In transverse profile the valve is moderately convex and has a slight median flattening which may develop into a narrow, shallow sulcus at the front; flanks are evenly convex. The valve is costate, and 25-27 relatively low, rounded costae with narrow interspaces are present at the margin of mature specimens. Flank costae arise on the umbo and within 2-3 mm. all but the outermost bifurcate; further bifurcation may occur on the venter at a valve length of approximately 5mm. A median costa finer than all others, also arises on the umbo and frequently remains undivided, although in F 3695 G.S.Q. it bifurcates twice about 4 mm. from the umbo and produces a group of three fine derivatives. The median costa and its derivatives occupy the median flattened, or sulcate portion of the valve. Concentric growth lines are strongly marked, particularly near the growth margin of mature valves.

The brachial valve is flat, but for a broad, very shallow depression that originates near the umbo and expands to the front of the valve. Costae are low, and all are bifurcated like those on the pedicle valve. On some valves the median and its derivatives are slightly elevated.

The muscle field in the pedicle valve is poorly defined except in thickened individuals. Adductors appear to occupy a low narrow central platform. These are flanked by variably impressed flabellate diductor scars, approximately four-tenths of the length of the valve. A short, extremely fine, low myophragm is often present posteriorly. Large, elongate hinge teeth are attached directly to postero-lateral walls; deep crural fossettes are incised along their medial surfaces over the posterior half of their length. Two rather strong vascular trunks extend anteriorly from the front of the adductor scars.

In the brachial valve, strong inner socket ridges or hinge plates are discrete and diverge at an angle of approximately 30° to postero-lateral margins (t. fig. 2); their anterior extremities are somewhat angular and presumably functioned as crural bases, but as valves are disarticulated, the spiralia are not preserved. Outer socket ridges have minute corrugations or crenulations on their articulating surface, but inner socket margins are completely smooth. Outer socket ridges are continued anteriorly almost to the midlength of the valve as pronounced marginal ridges. A moderately small, distinctly bilobed cardinal process is situated on a slightly thickened area between the hinge plates. A broad myophragm extends anteriorly from the process to the midlength; it reaches its greatest height (0·7mm.) close to its anterior extremity. Adductor scars are visible only on thickened valves. They are trigonal in outline, with the longest side adjacent to the myophragm over its entire length; posterior adductors are mostly deeply impressed.

FIG. 2. Cardinalia of *Neocoelia boucoti* gen. et sp. nov., × 18.

Dimensions (mm.).—

	Length	Width
F 3696 G.S.Q., Holotype, brachial valve	10·5	11·0
F 3693 G.S.Q., Paratype, pedicle valve	10·3	10·0
F 3687 G.S.Q., Paratype, pedicle valve	10·0	9·3

Remarks.—Chapman (1920) described a brachiopod from the Mitta Mitta River (? Upper Silurian) in Victoria as *Coelospira australis*. I have re-examined the holotype (P 13969 National Museum, Victoria), and contrary to Chapman who regarded it as a brachial valve, consider it to be the anterior portion of a pedicle valve which, by itself, is virtually indeterminate beyond saying that it appears to be a spiriferoid. The only other certain anoplothecid known to me from Australia is a species externally resembling *Coelospirina* Havlíček, collected by Dr. J. A. Talent from the Eifelian Pyramids Member, Taravale Formation, Victoria.

Suborder CHONETOIDEA Muir-Wood, 1955
Superfamily CHONETACEA Shrock and Twenhofel, 1953

Chonetidae gen. et sp. indet.

Pl. 1, fig. 10

Material.—Figured specimen F 9570 G.S.Q., and two other very fragmentary specimens.

Description.—The pedicle valve is large and semicircular in outline; cardinal extremities are obtuse and the hinge-line slightly shorter than the maximum valve width; lateral and anterior shell margins are continuously rounded. The interarea is relatively low and triangular, and the delthyrium open. The valve has very low even convexity and is ornamented by fine, infrequently bifurcated, rounded capillae which number 80-90 at its margin. The median septum is very short and moderately high; muscle scars can not be defined, possibly due to the absence of secondary shell thickening.

Dimensions.—Length 12mm., width *ca.* 22mm.

Remarks.—The valve is similar to *Chonetes taggertyensis* Gill from the Yeringian of Victoria (Gill 1945), and *C. sarcinulatus* (Schlotheim) in shape and ornamentation, but differs from both in its greater size and very much shorter median septum.

Phylum	MOLLUSCA
Class	BIVALVIA Linné
Superfamily	MYTILACEA Ferussac
Genus	MODIOMORPHA Hall, 1869.

Type Species.—*Pterinea concentrica* Conrad; from the Middle Devonian Hamilton Formation of New York.

Discussion.—Essential characters of the species described below are as follows:—

(1) Shape generally mytiloid with much reduced anterior; small umbos, terminal at maturity; moderately elongate, expanded posterior; body of the valve oblique to the cardinal margin; and almost straight ventral margin.

(2) Ornament of two subparallel grooves radiating from the umbo to the ventral margin near the postero-ventral extremity, and fine concentric growth lines.

(3) Ligament opisthodetic, possibly located in a narrow furrow inside the cardinal margin.

It is probably most closely comparable in shape and ornamentation with two Upper Silurian species that have been associated with *Orthonota* Conrad and *Grammysia* de Verneuil : *G. acadica* Billings from Nova Scotia and "*O. cingulata* Hisinger" of Phillips and Salter (1848, pl. 17, fig. 2) from the Usk district of Wales. The latter specimen was subsequently designated *G. cingulata* var. ? (*obliqua*) by McCoy (1852, p. 280). *Orthonota,* type *O. undulata* Conrad, has an extremely elongate shell with small anterior lobe and straight, posteriorly slightly divergent cardinal and ventral margins. Radial ornament is present only in the postero-dorsal sector. Ligament is parivincular. *Grammysia,* type *Pterinea bisculata* Conrad, typically has a large, inflated, ovoid or rhomboidal shell with more or less anteriorly situated, large, inrolled and anteriorly directed umbos, and prominent lunule. Valves are ornamented by two deep grooves arching from the umbo to the middle of the convex ventral margin, together with strong concentric ridges or rugae. Thus, the above group of species appears to be quite distinct from both *Orthonota* and *Grammysia.*

Overall morphology seems to relate the Queensland species at least, to the Mytilacea rather than the Grammysiacea, and it is here very tentatively associated with the Devonian genus *Modiomorpha* Hall whose shape is somewhat similar in many species. *Modiomorpha* lacks ornament of obliquely radiating grooves; the broad, shallow sulcus or depression extending from beneath the umbo to the middle of the gently concave ventral margin is basically dissimilar. *Volsellina* Newell from the Carboniferous and Permian, also has similar shape, although a small anterior lobe is regularly developed, and the only ornament is a narrow, oblique umbonal ridge. Future work will probably demand recognition of this species, and perhaps its Upper Silurian allies, in a separate new genus.

Modiomorpha (?) *levisulcata* sp. nov.

Pl. 1, figs. 11-15

Diagnosis.—Moderately inflated, sub-rhomboidal shells with small umbos situated in the anterior one-third of the length in juveniles, but terminal, and the anterior much reduced at maturity; posterior moderately elongate, expanded slightly in a dorso-ventral sense; body of valves oblique to the hinge and prosocline; ventral margin almost straight. Ornament of two narrow subparallel grooves that radiate from the umbo to the ventral margin near the postero-ventral extremity, and fine growth lines.

Material.—Holotype F 3682 G.S.Q.; paratypes F 9711-13, 3685 G.S.Q.; three other incomplete valves.

Description.—Valves rather strongly convex, apparently equal and very inequilateral. Outline approaches rhomboidal, and the height-width ratio is approximately 2:3. In the single juvenile specimen the umbo is situated almost one third of the length of the cardinal margin from the rounded anterior extremity, and is small, pointed and directed anteriorly. Adult specimens differ in that the umbo is terminal and the anterior very much reduced, so that the margin descends from the umbo in a broad curve almost at right angles to the cardinal margin. These shape differences are presumed to be due to growth inequalities. Posteriorly, valves are expanded slightly in a dorso-ventral sense, and the hinge margin sweeps dorsally a little before swinging obliquely to the rounded postero-ventral extremity. Ventral margin is almost straight. The body of the valves is always quite oblique to the hinge and prosocline. Valves are ornamented by very fine concentric growth lines, and a pair of moderately narrow, shallow grooves that radiate from the umbo to the ventral margin just anterior to the postero-ventral extremity.

In its interior, a low ridge extends posteriorly from beneath the umbo for one third of the valve length, at approximately 1mm. below the cardinal margin. It is possible that the ligament lay between this ridge and the margin and was entirely opisthodetic, at least at maturity. Musclature is poorly defined. The juvenile F 9711 G.S.Q. shows the anterior adductor situated antero-dorsally with its inner margin defined by a low curved ridge; F 9713 G.S.Q. has the posterior adductor situated postero-dorsally. As both adductors have not been seen on an individual, their relative size cannot be stated. Dentition, and shape of the pallial line are not known.

Dimensions (mm.).—

	Height	Width
F 3682 G.S.Q., Holotype	12	18
F 9711 G.S.Q., Paratype	4	7
F 9712 G.S.Q., Paratype	11	18

Remarks.—In a preliminary report (Day and McKellar, 1962), the species was tentatively compared with *Orthonota incerta* Billings and *O. simulans* Billings, as figured by McLearn (1924, pl. 19) from the Upper Silurian Stonehouse Formation of Nova

Scotia. The species have a series of four or five fine ridges and grooves radiating from the umbo to the ventral margin, and a very elongate outline like that of typical *Orthonota;* consequently, the resemblance to *Modiomorpha* (?) *levisulcata* sp. nov. is somewhat superficial.

Orthonota australis Chapman has a strong oblique groove that extends from the umbo to the ventral margin close to the postero-ventral extremity; however, the species is posteriorly much more elongate than *M.* (?) *levisulcata,* it has a posterior flattened area near the cardinal margin, and shell surface is partly rugose. It was described by Chapman (1908) from Upper Silurian strata at Flemington in the Melbourne area.

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EXPLANATION OF PLATE 1

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Figs. 1–9. *Neocoelia boucoti* gen. et sp. nov.

1*a*, F 3694 (*b*) G.S.Q., paratype; rubber cast of posterior portion of pedicle valve, X3.

1*b*, F 3694 (*a*) G.S.Q., paratype; internal mould of posterior portion of pedicle valve, X3.

2, F 3687 G.S.Q., paratype; internal mould of pedicle valve, X3.

3, F 3695 (*a*) G.S.Q., paratype; rubber cast of incomplete pedicle valve exterior, X3.

4*a*, F 3693 (*a*) G.S.Q., paratype; rubber cast of incomplete pedicle valve exterior, X3.

4*b*, F 3693 (*b*) G.S.Q., paratype; internal mould of thickened pedicle valve, X3.

4*c*, F 3693 (*b*) G.S.Q., paratype; rubber cast of pedicle valve interior, X3.

5, F 3690 G.S.Q., paratype; internal mould of incomplete, thickened brachial valve, X3.

6, F 9537, G.S.Q., paratype; rubber cast of brachial valve exterior, X3.

7, F 3688 (*a*) G.S.Q., paratype; internal mould of brachial valve, X3.

8, F 3689 (*a*) G.S.Q., paratype; rubber cast of brachial valve interior, X3.

9*a*, F 3696 (*a*) G.S.Q., holotype; rubber cast of brachial valve interior, X3.

9*b*, F 3696 (*b*) G.S.Q., holotype; external mould of brachial valve, X3.

9*c*, F 3696 (*b*) G.S.Q., holotype; rubber cast of brachial valve exterior; X3.

Fig. 10. *Chonetidae* gen. et sp. indet.

10, F 9570 G.S.Q.; internal mould of incomplete pedicle valve, X2.

Figs. 11–15. *Modiomorpha* (?) *levisulcata* sp. nov.

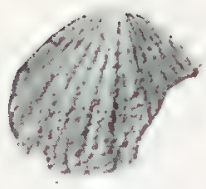
11, F 9711, G.S.Q., paratype; internal mould of immature left valve, X2.5.

12, F 3682 (*a*) G.S.Q., paratype; internal (composite) mould of mature left valve, X2.

13, F 9712 (*a*) G.S.Q., paratype; internal (composite) mould of right valve, X2.

14, F 9713 (*a*) G.S.Q., paratype; internal (composite) mould of incomplete right valve, X2.

15, F 3685 (*a*) G.S.Q., paratype; internal mould of crushed right valve, X2.1.



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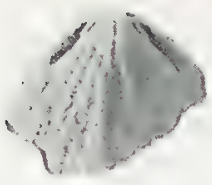

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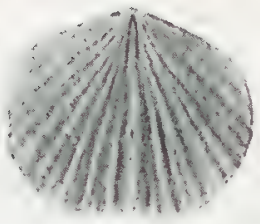

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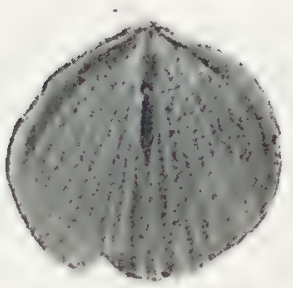

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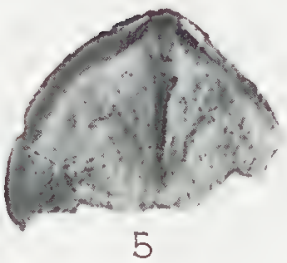

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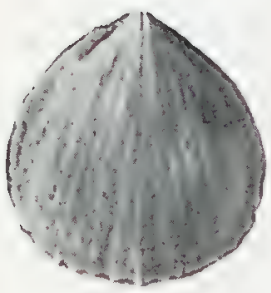

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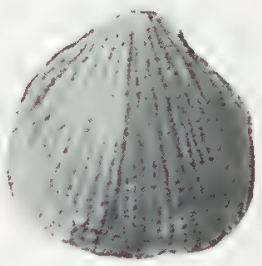

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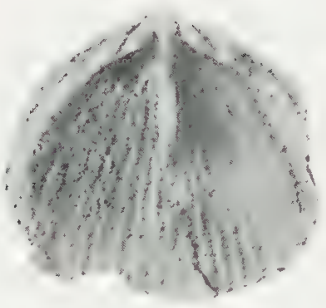

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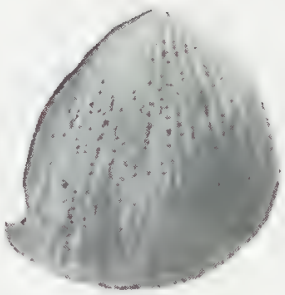

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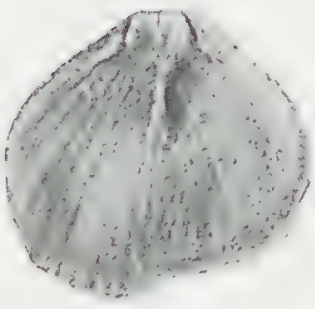

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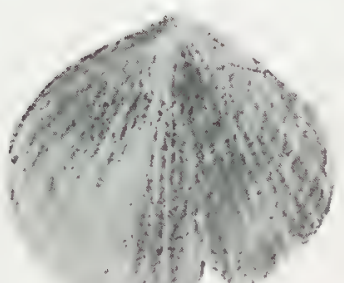

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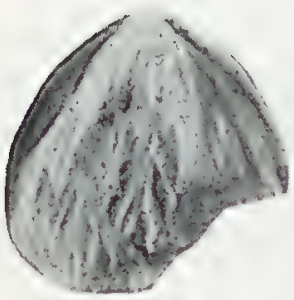

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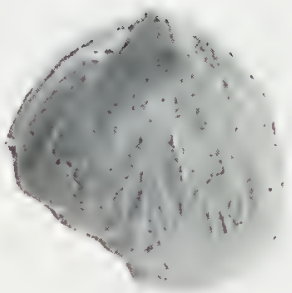

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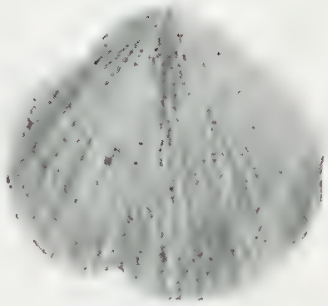

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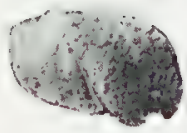

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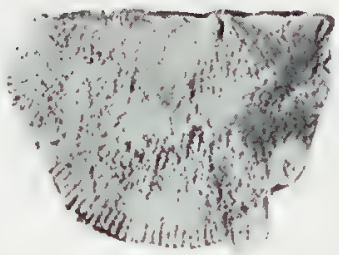

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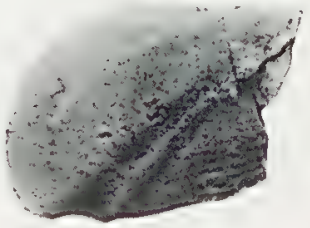

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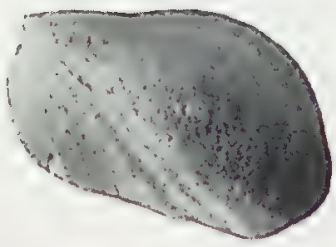

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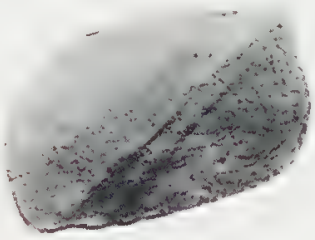

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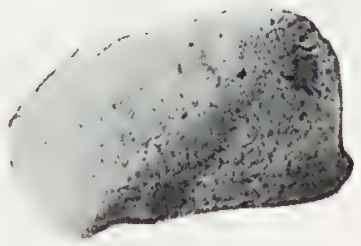

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PLATE 1

PALAEONTOLOGICAL PAPERS, No. 4

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ADDITIONAL BRACHIOPODS AND BIVALVES FROM THE ETONVALE FORMATION, ADAVALE BASIN, QUEENSLAND

R. G. McKellar

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

Two brachiopods and five bivalve molluscs are described from the interval 14,316–14,330 ft. in Phillips–Sunray Log Creek No. 1 well. These fossiliferous beds have been assigned to the lower black shale unit of the Etonvale Formation. The brachiopods are *Undispirifer* (?) *spinulatus* sp. nov. and *Rhipidothyris gowanensis* sp. nov.; the bivalves are *Actinopteria* (?) *adavalis* sp. nov. and unnamed species of *Actinopteria, Pterinopecten, Modiomorpha* and *Sphenotus*. A lower Middle Devonian (Eifelian) age is favoured for the fauna.

INTRODUCTION

The paper is written to further document the little known fauna of the Devonian Etonvale Formation in the subsurface Adavale Basin of Queensland. The most complete discussion of the stratigraphy of the basin presently available is that presented by Heikkila (1966); shorter notes on the subject are to be found also in McKellar (1966: this publication) and de Jersey (1966). The Devonian marine sediments in the Etonvale Formation were described by Phillips Petroleum Company (1964) from Etonvale No. 1 well (latitude 25° 09′ 40″ S., longitude 144° 59′ 40″ E.). The company now divides the formation into six members provisionally labelled D1, D2, D3, D4, unnamed shale and basal arkose.

The first work on the fossil fauna (McKellar, *op. cit.*) involved the description of the few fossils from the interval 9,615–9,617 ft. in Etonvale No. 1 well. This interval comes from the upper part of the unnamed shale member of the formation. The material described in this paper was obtained from the interval 14,316–14,330 ft. in Phillips–Sunray Log Creek No. 1 well, located 50 miles north-north-east of Adavale at latitude 25° 16′ 05″ S., longitude 144° 54′ 43″ E Phillips Petroleum Company currently assign the strata concerned to the unnamed shale member of the Etonvale Formation. This seems very reasonable on a lithological breakdown as the fossils are contained in black, moderately calcareous shales and silts. The fauna is predominantly molluscan with seven species of bivalve molluscs associated with two species of brachiopods and a single undetermined ostracod specimen. It appears to be a typical marine shelf assemblage.

The brachiopods are both small forms and are described in this paper as *Undispirifer* (?) *spinulatus* sp. nov. and *Rhipidothyris gowanensis* sp. nov. Of the bivalves, the pterioid *Actinopteria* (?) *adavalis* sp. nov. is quite abundant throughout the fossiliferous interval; other forms are less plentiful and as a consequence incompletely known. Four are briefly described, but no further specific names are introduced—*Actinopteria* (?) sp., *Pterinopecten* sp., *Modiomorpha* sp. and *Sphenotus* sp. Two small specimens of both *Grammysia* sp. and *Palaeoneilo* sp. are present, but do not warrant description. The collection has no species in common with that described in the earlier paper; however, *Actinopteria* (?) *adavalis* sp. nov. occurs at 9,333 ft. in the same well (Etonvale No. 1). This is of particular interest as at 282 ft (approximately 277 ft. true thickness) above the described brachiopod-bivalve fauna, it might be expected to have a similar age. This proposition is made in view of the rapid sedimentation in the basin, which is indicated by the accumulation of more than 3,500 ft. of sediment in Middle Devonian time. The fossils at 9,333 ft in Etonvale No. 1 well occur in the lower part of the D4 sandstone – shale member which spans the interval 7,662–9,540 ft. (Lewis and Kyranis, 1965).

The Age of the Fauna

The brachiopod *Undispirifer* Havlíček occurs in the Middle Devonian (Givetian) and Upper Devonian (Frasnian) of Europe, *fide* Boucot, Johnson, Pitrat and Staton, 1965. Plicate reticulariids of the type of *Undispirifer* and its analogues *Elita* Frederiks and *Elythina* Rzhonsnitskaya are typically found in strata of Middle Devonian (Eifelian) to Upper Devonian (Frasnian) age. Similar forms occur also in the Lower Devonian. Dr. J. G. Johnson (California Institute of Technology) has drawn my attention to *Spirifer laeviplicatus* Kozlowski from the Gedinnian of Poland, whose mirco-ornament seems to be that of a reticulariid (Kozlowski, 1929, pl. 10, fig. 27). The species, which is very similar to *U.* (?) *spinulatus* sp. nov., was referred by Kozlowski to his genus *Crispella* (= *Howellella* Kozlowski, 1946). The other brachiopod genus, *Rhipidothyris* Cooper and Williams, has been recorded previously only from sediments of upper Middle Devonian age (Ludlowville and Tully Formations) in North America. Its limited range may be subject to extension, as certain small costate Centronellidina in the Lower and Middle Devonian of Europe, that have in the past been referred to *Trigeria* Bayle (an objective synonym of *Retzia* King), may be

correctly assignable to *Rhipidothyris*. The ranges of the bivalve genera are not well established, but the species assemblage appears to have Middle or early Upper Devonian aspect. On the basis of these generic ranges alone, a Middle Devonian age is all that can be suggested.

The question of age can also be approached by relation of the Log Creek fauna to that of Etonvale No. 1 well. As mentioned, *Actinopteria* (?) *adavalis* sp. nov. occurs 277 ft. stratigraphically above the brachiopod-bivalve fauna of the interval 9,615–9,617 ft. which McKellar (1966) regarded as upper Lower Devonian (Emsian) or more probably, lower Middle Devonian (Eifelian) in age. With their proximity and superposition in the section, the fauna in Log Creek No. 1 well must have similar or slightly younger age; that is, an Eifelian age would be favoured.

Devonian spore assemblages from the Adavale Basin were examined and described by de Jersey (1966). He regarded the microflora from the interval beneath the D3 limestone member, that is, from D4 and the unnamed shale, as Middle Devonian, either upper Eifelian or lower Givetian in age. This age determination rests largely on the presence of the species *Phyllothecotriletes nigratus* (Naumova) and particularly, *Retusotriletes tenerimedium* Tschibrickova; however, in Etonvale No. 1 and Gumbardo No. 1, the only Phillips–Sunray wells where they are known, they do not occur in strata older than the D4 member. The unnamed shale member in Etonvale No. 1 well contains the spore genera *Endosporites* and *Spinozonotriletes* (Core 24, 10,000 ft.) and *Hystricosporites* (Core 23, 9,610 ft.). The occurrence is significant as all range from the Eifelian into younger strata elsewhere. This greatly reduces the likelihood of a Lower Devonian age for the shale member. In the older microfloras de Jersey (*op. cit.*) has noted the dominance of simple forms with smooth or finely ornamented exines over more complex forms which are normally abundant in Middle Devonian assemblages. He considered "that this distinctively different composition of the Queensland microfloras is related to local environmental conditions". It might also be argued that a relatively high proportion of very simple forms would be expected to persist in assemblages from the early part of the Middle Devonian. If the microfloral evidence for the age of the unnamed shale member is weighed against the faunal evidence, I believe an Eifelian age remains the most reasonable.

The repository for all specimens figured or mentioned in the paper is the Geological Survey of Queensland (G.S.Q.).

SYSTEMATIC DESCRIPTIONS

Phylum	BRACHIOPODA
Superfamily	SPIRIFERACEA King, 1846
Family	?RETICULARIIDAE Waagen, 1883
Genus	UNDISPIRIFER Havlíček, 1957

Type species (by original designation).—*Spirifer undiferus* Roemer, 1844; Middle Devonian (Givetian) of Germany.

Diagnosis.—Transversely oval spiriferoid shells with fold and sulcus broad and evenly rounded; lateral slopes with 4–6 rounded plications, sometimes obscure; micro-ornament of radially capillate growth lamellae fringed by minute, simple, prostrate spines; pedicle valve interior with dental lamellae; no median septum.

Remarks.—The small, plicate spiriferoid from Log Creek well has a very distinctive micro-ornament. It comprises wide growth lamellae fringed by minute prostrate spines of two sizes, the larger set posteriorly to the smaller; narrow grooves extend from beneath the spines for part, or less frequently, the entire width of a growth lamella. This micro-ornament is thought to be analogous to that of certain reticulariid genera, e.g. *Minatothyris* Vandercammen, as figured from *M. maureri* (Holzapfel) by Vandercammen (1957, fig. 4). For this reason, the shell is tentatively associated with the plicate genera of the family Reticulariidae Waagen. Of these, *Undispirifer* Havlíček and *Elythina* Rzhonsnitskaya have most similar shell shape, although the radial element of their mirco-ornament is more completely developed. *Elythina* can probably be eliminated as it is quite strongly plicate, the dorsal fold is medially sulcate, and the pedicle valve is heavily thickened posteriorly about the dental lamellae. The genus *Undispirifer* can be used only with reservation. It was described originally as a simple-spine analogue of *Elita* Frederiks, 1918 (= *Elytha* Frederiks, 1924) which is reputed to have specialized "double-barreled" spines. If *Elita* should prove to have only simple spines, and this is possible if the text-figure of Ivanova (1960, fig. 395) is reliable, then *Undispirifer* would become its junior subjective synonym.

The morphology of the Queensland species is also very similar to that of *Howellella* Kozlowski, 1946 (= *Crispella* Kozlowski, 1929) of the Delthyrididae Waagen. *Howellella* appears to be distinguishable by its micro-ornament of growth lamellae crossed by extremely fine, radially disposed capillae, each of which increases in strength to the front of a lamella where it is continued as a minute prostrate spine. It is interesting to note that Ivanova (1960) associated *Howellella* and *Undispirifer,* inappropriately I believe, in the subfamily Guerichellinae (an invalid subfamily name: Boucot, Johnson, Pitrat, and Staton, 1965, p. 689).

Distribution.—Middle Devonian (Givetian) and Upper Devonian (Frasnian) of Europe; possibly upper Lower Devonian and lower Middle Devonian of Eastern Australia.

Undispirifer (?) *spinulatus* sp. nov.

Pl. 2, figs. 13-20

Diagnosis.—Small transversely oval Reticulariidae with globose pedicle valve, and gently convex brachial valve. Fold and sulcus smooth; lateral slopes with three and sometimes four broad, low plications. Micro-ornament of well spaced, partly radially capillate growth

lamellae, each fringed with one or two rows of minute spines. Dental lamellae well developed; ventral myophragm short and extremely fine and low when present. Cardinal process very small, longitudinally striate; crural plates present.

Material.—Holotype F9852 G.S.Q.; paratypes F9851, 9853, 9855–9860, 10214 G.S.Q.; several other incomplete internal and external moulds.

Description.—The shell is small and its outline transversely oval; its length is about two-thirds of the width. Cardinal extremities are well rounded, and greatest width occurs near the midlength. Anterior profile is biconvex, the pedicle valve being the deeper; anterior commissure is uniplicate. The valves have three moderately low, evenly rounded plications, and often an incipient fourth plication laterally bounding each side of the sulcus and fold. The shell surface is ornamented by relatively well spaced growth lamellae which occur with a spacing of 3–4 per millimetre except at the margins of adults where they become crowded. The anterior margin of each lamella gives rise to a fringe of minute spines frequently arrayed in two very closely spaced rows: the posterior of coarser spines, 12–14 per millimetre, the anterior of finer spines alternating with those of the posterior row. In some, this arrangement is not apparent and a slightly irregular row of spines of similar size occurs. The spines are almost prostrate and a fine groove extends anteriorly from beneath each spine for part or all of the way across the growth lamella. This gives the lamellae a generally radially striate or capillate appearance.

The pedicle valve is strongly convex in both lateral and anterior profiles; precise distribution of shape is difficult to assess due to valve distortion. The median sulcus is broadly rounded and expanded into a short linguaform extension at the front of the valve. The umbo is acute and rather strongly hooked over a curved apsacline interarea of moderate height (1·5 mm. on F9855 G.S.Q.). The delthyrium is fairly narrow and open to the umbo. The brachial valve has rather low, even convexity although some flattening occurs toward the lateral extremeties. The median fold is well developed, rounded in transverse profile, and clearly delimited by deep interspaces. The interarea is very low.

Internally, the pedicle valve has long unthickened, slightly divergent or subparallel dental lamellae. Usually, they extend along the internal surface over the interspace between the first and second plications lateral to the sinus, but they may recurve slightly and then encroach on the area over the first plication. Their length seems to be quite variable between one quarter, and one half of the valve length. A myophragm is usually absent, but on F9860 G.S.Q. it is very fine, low, and extends from the umbo for approximately 3–4 mm. The muscle field is not defined on the few available specimens. In the brachial valve, the cardinal process is very small, sessile, and triangular in outline. Its surface is indistinctly striate, except in F9859 G.S.Q. in which the striae appear to be replaced by rows of papillae; however, it is possible that this papillose surface is due simply to incomplete leaching of the mould. Socket plates are well developed although fairly narrow. They are supported at their inner (medial) edges by curved crural plates that extend anteriorly from the umbo along the floor of the valve for 1–1·5 mm. A very fine, low myophragm 2 mm. in length is sometimes present, but the adductor sites are not impressed.

Dimensions (mm.).—

	Length	Width
F 9852, Holotype, pedicle valve	8	11
F 9851, Paratype, brachial valve	5·5	8
F 9860, Paratype, pedicle valve	10	14

Remarks.—Certain Australian species that are presently assigned to *Howellella* Kozlowski appear to be quite similar to *U.* (?) *spinulatus* sp. nov. Two such species are *H. scabra* Philip and *H. textilis* Ta'ent. *H. scabra* was described by Philip (1962) from the Coopers Creek Formation and Boola Beds of the Tyers area in Victoria. It has comparable shape and plication, but its cardinal area is higher, and the fold and sulcus wider and more pronounced. Growth lamellae appear to be more closely spaced on its surface, but this character can be expected to be quite variable. The age of these beds was considered to be lowermost Devonian (Gedinnian) by Philip (*op. cit.*, p. 246), but Talent (1965, fig. 2) now regards them as somewhat younger, and places them about the Siegenian-Emsian boundary. *H. textilis* Talent occurs in the Kilgower Member of the Tabberabbera Formation in the Mitchell and Wentworth Rivers area of Victoria. It is more sharply plicate, and its fold and sulcus are narrower and deeper than those of *U.* (?) *spinulatus* sp. nov.; four plications are usually present on each lateral slope. In addition, the myophragm in its pedicle valve is frequently well developed. Talent (1963, 1965) regards the formation as Lower Devonian (Emsian) in age.

Superfamily	STRINGOCEPHALACEA King, 1850
Family	RHIPIDOTHYRIDIDAE Cloud, 1942
Subfamily	RHIPIDOTHYRIDINAE Cloud, 1942
Genus	RHIPIDOTHYRIS Cooper and Williams, 1935

Type Species (by original designation).—*Rhipidothyris plicata* Cooper and Williams, 1935; from the late Middle Devonian Tully Formation (Gilboa Beds) of New York State.

Diagnosis.—Small, lenticular, costate Centronellidina with a concave, imperforate cardinal plate supported for all or part of its length by a long or short dorsal median septum. Dental plates present. Pedicle foramen submesothyrid, deltidial plates conjunct. (Adapted from Cloud, 1942, p. 87.)

Distribution.—Upper Middle Devonian: Ludlowville Formation (Tioughniogan Stage) and Tully Formation (Taghanican Stage) of Eastern United States. Probably lower Middle Devonian in Queensland.

Rhipidothyris gowanensis sp. nov.

Pl. 2, figs. 1–8

Diagnosis.—Small *Rhipidothyris* with the brachial valve less convex than the pedicle valve. Costae 16–18 at maturity, strong and rounded near margins of shell but dying out umbonally; costae broad in median sector of some specimens. Dental lamellae short and unthickened; dorsal median septum usually two-thirds of valve length.

Material.—Holotype F9837 G.S.Q.; paratypes F9835–6, 9838, 9840–2, 10213 G.S.Q.; several incomplete valves.

Description.—The shell is very small, with a maximum length of 8 mm., and is subcircular in outline. Although the anterior profile is biconvex, sublenticular, the pedicle valve is somewhat deeper than the brachial valve. The anterior commissure is straight. Valves are ornamented by relatively low, rounded costae which appear to arise just forward of the umbo and increase in size to the anterior margin where they number 16–18 in adults. They are largest in the median sector of the valves and decrease in size toward the lateral margins. Rarely, the median pair of costae are particularly broad—up to twice the normal width. Some bifurcation of the costae may occur near the midlength, but it does not appear to be a frequent occurrence. The posterior 2 mm. of the valves is very indistinctly costate and often apparently smooth, but for fine growth lines. The shell substance is strongly punctate in an echelon arrangement, and the punctae have a density of approximately 570 per square millimetre.

The pedicle valve has low to moderate convexity in both lateral and anterior profiles; there is no median fold or sinus. The umbo is small, sub-erect, and perforate; the palintrope short and not sharply set off from the umbonal slopes. The cardinal margin is submegathyrid. The brachial valve has low, even convexity, but is frequently crushed almost flat. Its umbo is inconspicuous.

The interior of the pedicle valve has very short, fine dental lamellae which are slightly divergent anteriorly. There are no visible muscle scars or myophragm. In the brachial valve there is no cardinal process. A relatively high, fine median septum extends approximately two-thirds of the length of the valve and supports a well developed cardinal plate. Lateral portions of the plate bear narrow, elongate sockets almost parallel to the hinge margin; the inner, ventrally concave portion is essentially a crural trough (nomenclature of Cloud, 1942).

Dimensions (mm.).—

	Length	Width
F 9837, Holotype, brachial valve	—	8
F 9838, Paratype, brachial valve	4·5	5
F 9836, Paratype, pedicle valve	6·5	6
F 9840, Paratype, brachial valve	8	8

Remarks.—*Rhipidothyris gowanensis* sp. nov. has a strong resemblance to the type species, *R. plicata* Cooper and Williams. It differs only in the slightly lower convexity of the brachial valve, the tendency to produce broad median costae, and the greater length of the dorsal median septum (two-thirds of valve length). The similarity of costation is particularly interesting, as both have low rounded costae that die out posteriorly. In *R. lepida* (Hall) the costae are angular or subrounded and distinct to the umbos. *R. plicata* occurs in the lower Gilboa Beds of the Tully Formation, and is late Middle Devonian in age.

Phylum	MOLLUSCA
Class	BIVALVIA Linné
Family	LEIOPTERIIDAE Maillieux, 1931
Genus	ACTINOPTERIA Hall, 1884

Type species.—*Avicula decussata* Hall, 1843, by subsequent designation of Bassler, 1915; from the Middle Devonian Hamilton Group of New York State.

Remarks.—Three genera have generally similar shape, biconvexity and ornamentation to the present form. They are *Actinopteria* Hall, *Ptychopteria* Hall and *Actinopterella* Williams.

The type of *Actinopteria, Avicula decussata* Hall, is reputed by Hall (1884, p xii and 112) and Williams and Breger (1916, p. 183) to be without teeth, and to have an extremely narrow ligament area with a single attachment groove. Hall (1884, p. xii) regarded the type of *Ptychopteria, P. salamanca* Hall, as similar to *Actinopteria,* but having an acutely pointed (nasute) anterior extremity, and hinge "furnished with one or two linear oblique cardinal and lateral teeth". Despite this preliminary note on the dentition, no further description of it is given in text, nor do his figures show it. Maillieux (1931, p. 70) regarded the hinge as having one cardinal tooth beneath the umbo, and one lateral tooth. The radial sculpture of *Ptychopteria* appears to be considerably finer than that of *Actinopteria. Actinopterella,* type *Pterinea radialis* Clarke, has three to five relatively large, elongate cardinal teeth, a moderately broad ligament area, and one or two lateral teeth immediately below the ligament area. It seems to be quite distinct from the present species. The form of the cardinal area and teeth make *Actinopterella* broadly analogous to *Pterinea* Goldfuss, *Cornellites* Williams etc., and their association in the Pterineidae Dall seems justified (Maillieux, *op. cit.,* p. 62).

The species from Log Creek No. 1 well resembles *Ptychopteria* in the size of the anterior lobe, and disposition of the sulcus delimiting it from the body of the valves; however, like *Actinopteria* the anterior extremity is rounded, and the posterior wing curves to the body well forward of the posterior extremity. It has three very small subumbonal teeth. As there has never been a critical revision of the hinge structure in the types of *Actinopteria* and *Ptychopteria,* I doubt that comparison of our material with them in this respect is worthwhile at the present time. Shape and surface sculpture are probably the only available criteria for the differentiation of the two genera. With these characters in mind, tentative association with *Actinopteria* seems to be the most suitable course.

Actinopteria (?) *adavalis* sp. nov.

Pl. 3, figs. 9–19

Diagnosis.—Moderately small, extremely oblique Leiopteriids with small rounded anterior and elongate posterior. Posterior wing relatively narrow, about half length from umbo to posterior extremity. Left valve with entire surface radially costellate; costellae very fine and "double-barrelled" on the posterior, much coarser on the anterior; growth lines inconspicuous posteriorly, strong anteriorly and elevated as spine-like varices at intersections with costellae. Right valve finely costellate in postero-dorsal sector only; growth lines fine and regular. Cardinal area linear; three minute subumbonal teeth in each valve; ligament of chevron-groove type.

Material.—Holotype, F9897 G.S.Q.; paratypes, F9890–93, 9895–6, 9898–9, 9903, 9912, 10215 G.S.Q.; several other valves.

Description.—Shells are moderately small for the genus, and are very inequilateral, unequally biconvex, and slightly inequivalve. The body of the shell is narrow and extremely oblique to the hinge margin (25°); the height is approximately half of the length. Umbos are fairly broad and protrude above the hinge margin. No anterior wing is developed and the cardinal margin appears to curve smoothly to the anterior lobe. The posterior wing extends about half the distance from the umbo to the postero-dorsal extremity, but due to the extreme obliquity of the body, it is never very broad. Both valves are convex, although the left is deeper than the right. In addition, the right valve appears to be a little smaller than the left.

The left valve has a moderately small anterior whose length is usually only one-eighth of the total valve length. The anterior lobe is set off from the remainder of the valve by a shallow sulcus which extends from the umbo to the ventral margin, almost at right-angles to the hinge. A small radial fold is sometimes present near the cardinal margin of the lobe. The posterior is relatively narrow, very elongate, and curved so that the dorsal margin posterior to the wing is nearly parallel to the hinge. The margin of the valve has quite a characteristic shape. It descends very steeply from the anterior extremity to a point just posterior of the sulcus that delimits the anterior lobe, then swings in a broad smooth curve along the venter to the posterior extremity. The posterior wing is almost flat, or very gently folded near the hinge margin, and is clearly set off from the body by a strong sulcus. Its posterior extremity is acutely pointed or mucronate. The valve is ornamented by radial costellae which are strong on the anterior lobe, but very fine elsewhere on the body and wing. On the posterior of well preserved specimens, they are usually divided by an extremely fine groove along their crest, giving them a "double-barreled" appearance. The costellae occur in three or four orders on mature valves, and new orders arise by intercalation between existing costellae. Concentric growth ridges are strong on the anterior lobe, and at their intersections with the costellae they are elevated in small spinose projections. Over the remainder of the valve they are inconspicuous, excepting the major growth halts which partly disrupt the radial costellae. Some mature valves have a band of very closely spaced growth lines along their postero-dorsal margin.

The right valve has similar shape to the left; however, the sulci delineating the anterior lobe and posterior wing are somewhat shallower and less clearly defined. The ornament differs considerably from that of the left valve. Radial costellae are visible only on the postero-dorsal sector of the valve, including the posterior wing. Growth lines or ridges are well marked and closely and regularly spaced over the entire surface.

Musclature of the valves is incompletely known. I have been unable to find any trace of an anterior adductor on the available specimens. A rather small, very shallow rounded depression on the body of valves near the postero-dorsal margin (toward the extremity of the wing) may represent the posterior adductor. The cardinal area is extremely narrow, elongate, and projects at a high angle to the plane of the commissure, except beneath the umbo where it is recurved almost to the plane of the wing, and minute teeth are borne on it. The left valve has three subumbonal teeth which are radially disposed with respect to the umbo; laterals have not been recognised. The anterior tooth is broadly triangular in outline, the middle tooth narrow and elongate, and the posterior very small, narrow, and obliquely inclined posteriorly. The hinge of the right valve has not been examined, but dental sockets in the left valve are indicative of three subumbonal teeth that decrease in size posteriorly. The ligament seems to be amphidetic and parivincular. Two ligament grooves appear to be present on the area behind the umbo. They diverge at a very low angle to the hinge margin—apparently constituting the posterior portion of the chevron pattern seen in Devonian pterioids.

Dimensions (mm.).—

	Height	Length
F 9897, Holotype, left valve	14	25
F 9896, Paratype, left valve	13	25
F 9903, Paratype, left valve	9	14
F 9912, Paratype, left valve	15	24

Remarks.—One left and one right valve of the species occur also in a core-cut from 9,333 ft. in Phillips-Sunray Etonvale No. 1 well. The interval concerned is in the lower part of the D4 member of the Etonvale Formation. The specimens are figured on pl. 3, figs. 9, 10. No closely similar species have been described from Australia.

Actinopteria (?) sp.

Pl. 3, figs. 1-3

Material.—Figured specimens, F 9901, 9902, 10216 G.S.Q.

Remarks.—Three specimens of this form, all left valves, occur in the collection. The valves broadly resemble *A.* (?) *adavalis* in their degree of obliquity,

the width and relative length of the posterior wing, and in the kind of ornamentation. They differ in several respects:

(i) The sulcus delineating the anterior lobe is inclined posteriorly and the lobe itself is relatively larger, more protuberant, and more strongly arched in a dorso-ventral sense.

(ii) The posterior is very narrow, and without the overall curved outline seen in *A.* (?) *adavalis.*

(iii) The antero-ventral margin of the valve is straight, or concave over the radial sulcus, and it merges into the gently convex ventral margin without noticeable angulation.

(iv) Costae are very strongly developed, particularly on the anterior lobe, and occur in only two orders. Growth lines are not strongly marked.

(v) The valves are considerably smaller than mature specimens of *A.* (?) *adavalis.*

Dimensions (mm.).—

	Height	Length
F 9902, left valve	8·5	17
F 9901, left valve	8·5	18

Family PTERINOPECTENIDAE Newell, 1937

Genus PTERINOPECTEN Hall, 1883

Type Species.—Pterinopecten undosus Hall, 1883, by subsequent designation of Miller, 1889; from the Middle Devonian Hamilton Group of New York State.

Remarks.—McAlester (1962, p. 49) has given the most recent résumé regarding the status of the genus. He differentiated *Pterinopecten* Hall and *Lyriopecten* Hall from *Pseudaviculopecten* Newell on their ill-defined auricles on the left valve. *Lyriopecten* is generally separated from *Pterinopecten* by its very small left anterior auricle, and the very pronounced development of the first order costae relative to those of other orders. McAlester doubts that *Pterinopecten undosus* Hall, the type, and *Avicula orbiculata* Hall, the poorly known type of *Lyriopecten,* are generically distinct, but follows Newell (1937) and accepts them both for the present time.

Pterinopecten sp.

Pl. 2, figs. 9-12

Material.—Figured specimens, F 9908-9911 G.S.Q.; three other fragmentary specimens.

Description.—The species is represented by one right valve and several left valves, all but one of which appear to have been broken before burial. The shell is of small to medium size and subcircular in outline, with the length slightly greater than the height. It is inequilateral, the posterior being considerably larger than the anterior, and acline or slightly prosocline. The left valve is only gently convex in both longitudinal and transverse profiles. The anterior ear is small and clearly defined by a radial sulcus; the posterior ear, although moderately large and flattened, is not differentiated from the body by an abrupt change in slope. The cardinal margin is straight and only slightly shorter than the maximum shell length at the mid-height. Cardinal extremities are pointed, but not mucronate. Anterior, ventral and postero-ventral margins of the valve are smoothly curved, but between the mid-height and the pointed cardinal extremity on the posterior side the margin is almost straight. The body of the valve is ornamented by sharp, prominent radial ridges, or costae, of two or three orders. On the ears this radial sculpture is very fine and more effectively delineates the posterior ear than any other character. Concentric growth lines are not very conspicuous.

The single, immature right valve is incomplete, with the anterior largely broken off before fossilization. The body of the valve has similar convexity to the left valve; ears are somewhat flattened. Growth lines close to the umbo on the anterior indicate that in early growth stages there was no development of a byssal notch; the anterior cardinal extremity in these stages was acutely pointed. The ornament of the body and posterior ear is closely similar to that of the left valve. On the remaining portions of the anterior, costae occur in one or two orders only; on the posterior in two or three orders. The posterior ear is finely costate. Hinge features, musclature and pallial line are unknown.

Dimensions (mm.).—

	Height	Length
F 9910, left valve	13	15
F 9911, left valve	14·5	–

Family MODIOLOPSIDAE Fischer emend. Dall, 1895

Genus MODIOMORPHA Hall, 1869

Type Species.—Pterinea concentrica Conrad, 1838, by subsequent designation of Hall, 1885, p. xxiii; from the Middle Devonian Hamilton Group of New York State.

Modiomorpha sp.

Pl. 3, figs. 7-8

Material.—Figured specimens F 9913-4 G.S.Q.

Description.—Two right valves of this species occur in the collection. They are small for the genus, very inequilateral, and rather strongly inflated. The umbo is broad, very low, and situated close to the rounded anterior extremity. The posterior is elongate, particularly in the larger, probably mature specimen, and expanded in a dorso-ventral sense so that behind the umbo the cardinal margin swings dorsally a little before curving around to the well-rounded posterior margin. Convexity is greatest in this posterior portion of the valve, although close to the cardinal margin a narrow flattened rim is present. A broad very shallow sulcus extends from the umbo to about the midlength of the gently concave ventral margin. The surface of the valve is smooth, or marked by very fine, indistinct growth lines. Hinge characters, musclature and pallial line are unknown.

Dimensions (mm.).—

	Height	Length
F 9913, right valve	5	10
F 9914, right valve	2	3·5

Remarks.—The species differs considerably from *Modiomorpha* (?) *levisulcata* described by McKellar (1966) from 9615 ft. (unnamed shale unit, Etonvale Formation) in Etonvale No. 1 well. *M.* (?) *levisulcata* can be distinguished readily by its ornament of two narrow, subparallel grooves that radiate from the umbo to the ventral margin near the postero-ventral extremity. In addition, the Log Creek species is much smaller, proportionately more elongate, and its umbo is broader.

Family ?SANGUINOLITIDAE Hall, 1885

Genus SPHENOTUS Hall, 1885

Type Species.—*Sanguinolites arcaeformis* Hall and Whitfield, 1869, p. 40, by subsequent designation of Miller, 1889, p. 513; from the Middle Devonian Hamilton Group of New York State.

Remarks.—Hall (1885, p. xxxiii) defined *Sphenotus* as having, "narrow cardinal teeth beneath the beak of the right valve, and with one or two extremely slender lateral teeth". McAlester (1962, p. 61) states that dentition cannot be convincingly demonstrated in the type, *Sanguinolites arcaeformis* Hall and Whitfield, or any other of the species assigned to the genus by Hall. He separates the genus from other Palaeozoic edentulous genera on the shape and sculpture of the shell. This course has been followed here.

Sphenotus sp.
Pl. 3, figs. 4-6

Material.—Figured specimens, F 9915-7 G.S.Q.

Description.—Shells are of medium size for the genus, gently biconvex, equivalve, and very inequilateral. The outline is very elongate and the length is more than twice the height. The umbos are anteriorly situated and prosogyral; a well developed angulation or umbonal ridge extends from each to the postero-ventral extremity. The cardinal margin is straight or very gently curved; the anterior margin acutely pointed; the ventral margin gently curved (convex) in the young, later straight; the posterior margin almost straight, but oblique to the cardinal margin; and the postero-ventral extremity acutely rounded. Both valves are strongly and regularly concentrically rugose on their anterior and ventral portions, but only indistinctly rugose or simply marked by lines of growth on the dorsal slopes. The hinge characters, musclature, and pallial line are unknown.

Dimensions.—F 9915: height 12 mm., length 28 mm.

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EXPLANATION OF PLATE 2

PALAEONTOLOGICAL PAPERS, NO. 4

FIGS. 1-8. *Rhipidothyris gowanensis* sp. nov.

1a, F 9836 (a) G.S.Q., paratype; internal mould of pedicle valve; x 2.

1b, F 9836 (a) G.S.Q., paratype; internal mould of pedicle valve; x 4.

2, F 9838 G.S.Q., paratype; internal mould of brachial valve with poorly preserved umbonal area; x 3.

3, F 9835 G.S.Q., paratype; internal mould of brachial valve; note broad median costae; x 3.

4, F 9839 G.S.Q.; internal mould of imperfect brachial valve; x 3.

5a, F 10213 (a) G.S.Q., paratype; internal mould of brachial valve and portion of the pedicle valve; x 6.

5b, F 10213 (a) G.S.Q., paratype; same as above; x 3.

6a, F 9837 (a) G.S.Q., holotype; internal mould of brachial valve and umbo of pedicle valve; x 2.

6b, F 9837 (a) G.S.Q., holotype; same as above; x 5·5.

6c, F 9837 (a) G.S.Q., holotype; internal mould of umbonal areas of brachial and pedicle valves; x 12.

7, F 9842 G.S.Q., paratype; internal mould of large pedicle valve; x 4.

8, F 9841 G.S.Q., paratype; crushed brachial valve showing punctation; x 6.

FIGS. 9-12. *Pterinopecten* sp.

9, F 9910 (a) G.S.Q.; incomplete internal (composite) mould of immature right valve; x 2·5.

10, F 9908 G.S.Q.; distorted internal (composite) mould of left valve; x 2·5.

11, F 9909 (a) G.S.Q.; incomplete internal (composite) mould of left valve; x 2·5.

12, F 9911 G.S.Q.; incomplete internal (composite) mould of left valve; x 2·5.

FIGS. 13-20. *Undispirifer* (?) *spinulatus* sp. nov.

13a, F 9851 G.S.Q., paratype; internal mould of brachial valve; x 2.

13b, F 9851 G.S.Q., paratype; same as above; x 3.

14, F 9856 G.S.Q., paratype; internal mould of distorted brachial valve; x 2.

15, F 9858 G.S.Q., paratype; posterior view of internal mould of brachial valve showing crural plates; x 3.

16, F 9855 G.S.Q., paratype; posterior view of incomplete internal mould of pedicle valve showing dental lamellae; x 2.

17, F 9860 (a) G.S.Q., paratype; distorted internal mould of pedicle valve showing dental lamellae and inconspicuous myophragm; x 2.

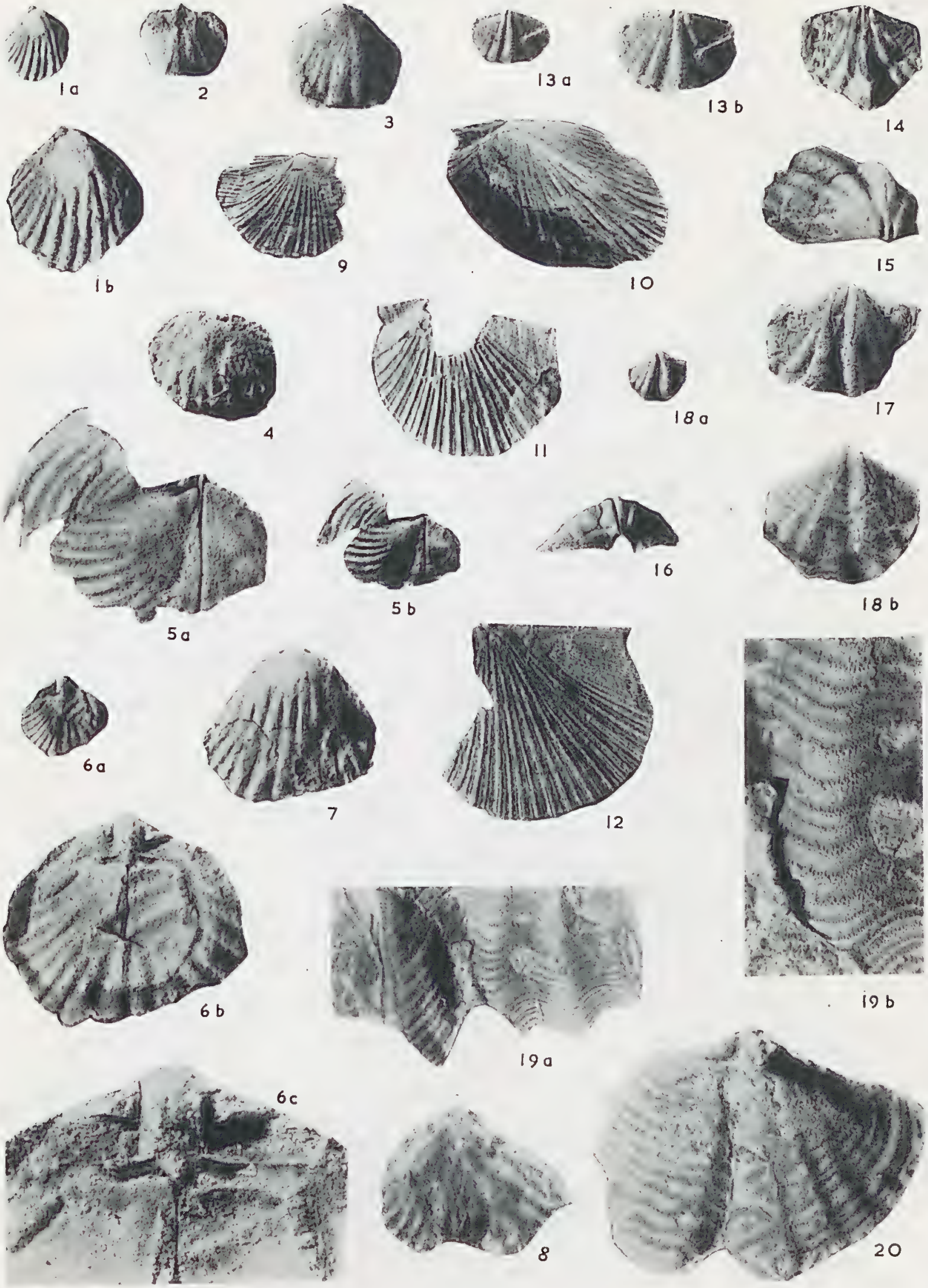
18a, F 9852 (a) G.S.Q., holotype; internal mould of pedicle valve (incompletely leached); x 1.

18b, F 9852 (a) G.S.Q., holotype; same as above; x 3.

19a, F 9853 (b) G.S.Q., paratype; portion of external mould of pedicle valve to show micro-ornament; x 6.

19b, F 9853 (b) G.S.Q., paratype; same as above; x 12.

20, F 9857 G.S.Q., paratype; external mould of pedicle valve to show micro-ornament; x 6.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18b
6a
7
12
19b
6b
19a
6c
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PLATE 2

EXPLANATION OF PLATE 3

PALAEONTOLOGICAL PAPERS, No. 4

FIGS. 1-3. *Actinopteria* (?) sp.

1a, F 9902 (a) G.S.Q.; internal (composite) mould of left valve; x 2.

1b, F 9902 (a) G.S.Q.; internal (composite) mould of left valve; x 1.

2, F 9901 (a) G.S.Q.; internal (composite) mould of left valve; x 2.

3, F 10216 G.S.Q.; internal (composite) mould of incomplete left valve; x 3.

FIGS. 4-6. *Sphenotus* sp.

4, F 9916 (a) G.S.Q.; internal (composite) mould of incomplete left valve; x 1.

5, F 9917 (a) G.S.Q.; internal (composite) mould of incomplete right valve; x 1·5.

6, F 9915 (a) G.S.Q.; internal (composite) mould of left and right valves; x 1·5.

FIGS. 7-8. *Modiomorpha* sp.

7, F 9914 (a) G.S.Q.; internal mould of right valve; x 4.

8, F 9913 (a) G.S.Q.; internal mould of right valve; x 3.

FIGS. 9-10. *Actinopteria adavalis* sp. nov.—Etonvale No. 1 well.

9a, F 3401 (a) G.S.Q.; internal (composite) mould of right valve; x 1.

9b, F 3401 (b) G.S.Q.; internal (composite) mould of right valve; x 1·5.

10, F 10236 (a) G.S.Q.; internal (composite) mould of incomplete left valve; x 1.

FIGS. 11-19. *Actinopteria adavalis* sp. nov.—Log Creek No. 1 well.

11, F 9899 (b) G.S.Q., paratype; rubber cast of incomplete left valve exterior; x 1·5.

12, F 9895 G.S.Q., paratype; internal (composite) mould of right valve and umbonal portion of left valve; x 2.

13, F 9903 G.S.Q., paratype; internal (composite) mould of immature left valve; x 2.

14a, F 9892 G.S.Q., paratype; internal (composite) mould of large left valve; x 1·5.

14b, F 9892 G.S.Q., paratype; internal (composite) mould of left valve; x 1.

15, F 9912 (a) G.S.Q., paratype; internal (composite) mould of left valve; x 2.

16a, F 10215 (b) G.S.Q., paratype; rubber cast of incomplete left valve exterior; x 1·5.

16b, F 10215 (b) G.S.Q., paratype; rubber cast of left valve exterior; x 1.

17a, F 9897 (b) G.S.Q., holotype; rubber cast of left valve exterior; x 1·7.

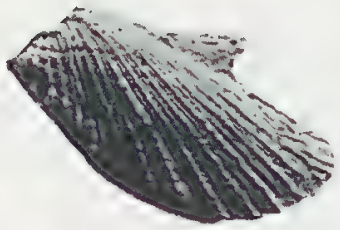
17b, F 9897 (a) G.S.Q., holotype; internal (composite) mould of left valve; x 1.

17c, F 9897 (a) G.S.Q., holotype; internal (composite) mould of left valve; x 2.

18, F 9893 G.S.Q., paratype; internal (composite) mould of incomplete left and right valves; x 2.

19a, F 9896 (a) G.S.Q., paratype; internal (composite) mould of left and right valves; x 1.

19b, F 9896 (a) G.S.Q., paratype; internal (composite) mould of left and right valves; x 2.



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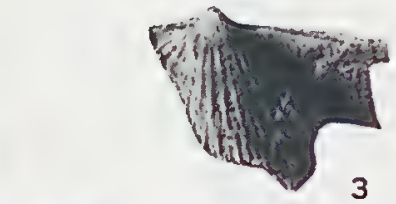

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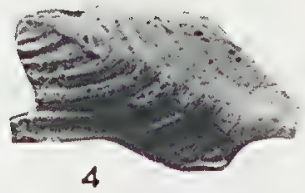

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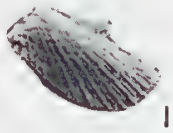

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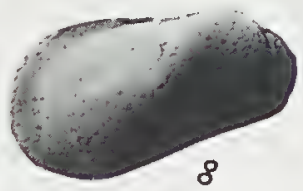

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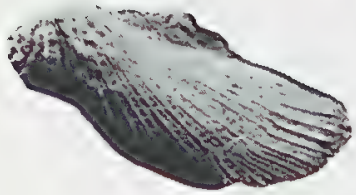

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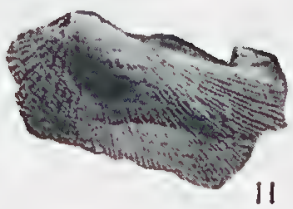

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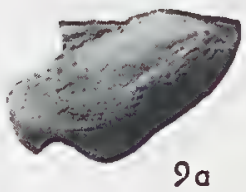

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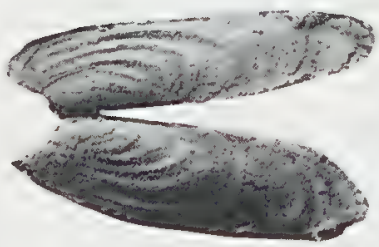

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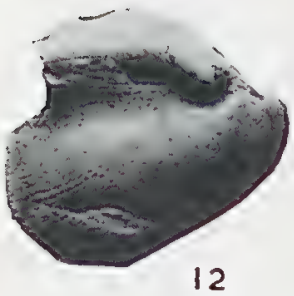

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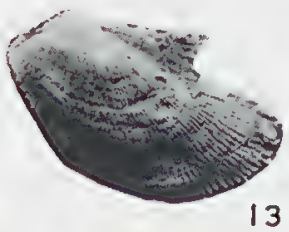

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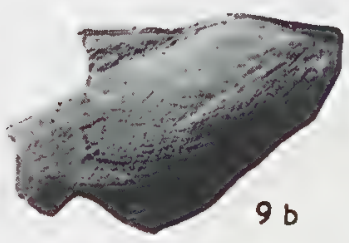

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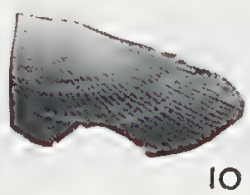

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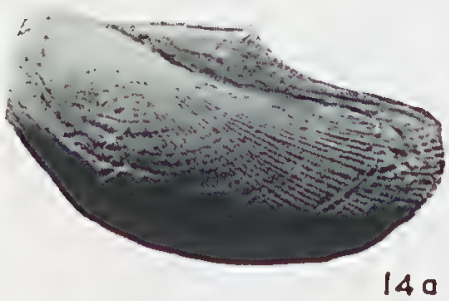

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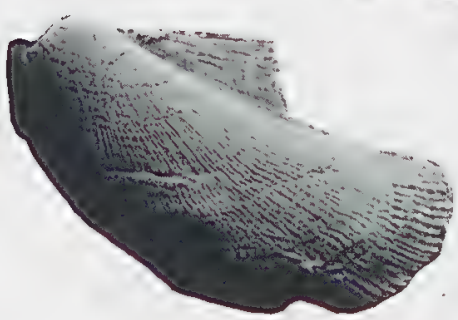

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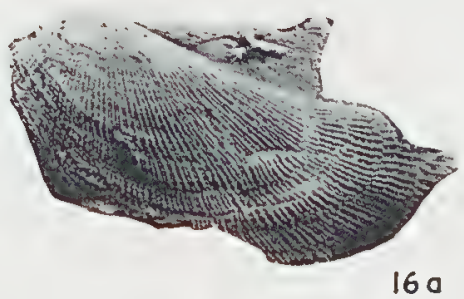

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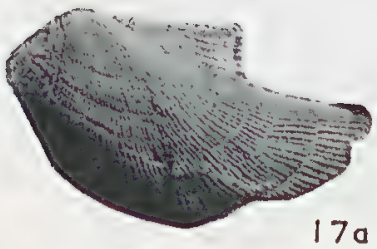

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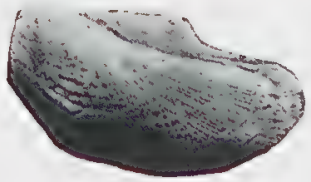

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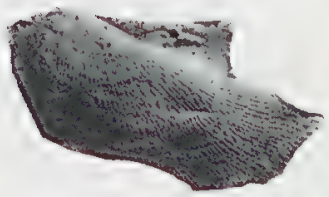

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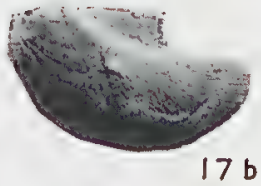

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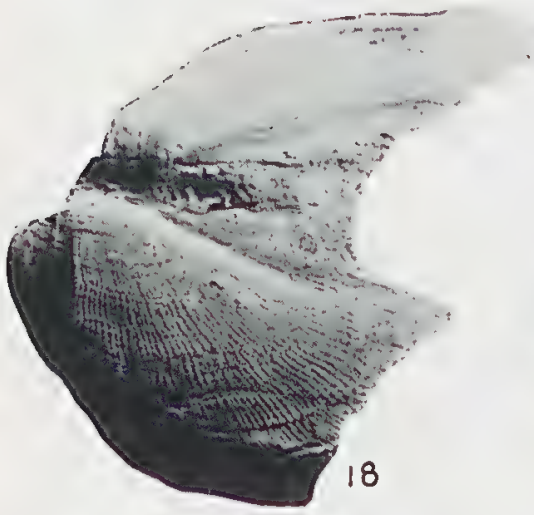

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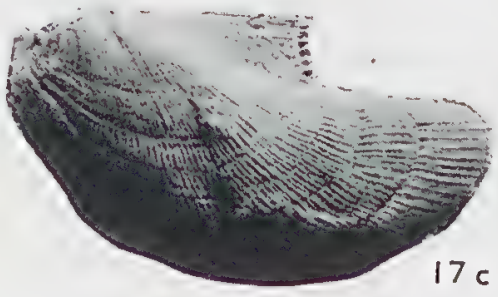

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19b

PLATE 3

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QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

PUBLICATION No. 333

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P. J. G. FLEMING

BRISBANE
[illegible]
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A NEW DEVONIAN FENESTELLID FROM QUEENSLAND, THE TYPE OF A NEW SUBGENUS OF *FENESTELLA*

by

P. J. G. FLEMING

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

A new subgenus of *Fenestella* Lonsdale, *Bajoola,* is proposed for the reception of a new species from the Middle Devonian of central Queensland, *F.* (*Bajoola*) *capellae* sp. nov. A number of Upper Palaeozoic species described from other Australian deposits are referred to the new subgenus.

INTRODUCTION

A fenestellid species, the first Devonian bryozoan to be described from Queensland, is discussed in this paper, and a new subgenus of *Fenestella, Bajoola* subgen. nov. (type *B. capellae* sp. nov.) proposed to contain it and a number of other Upper Palaeozoic fenestellids. *Fenestella* (*Bajoola*) *capellae* was first collected by members of the combined Bureau of Mineral Resources — Geological Survey of Queensland field party which mapped the Rockhampton area in 1965. The locality is at map reference 34870374, Rockhampton 4-mile military sheet area. It is on the northern slope of the hill immediately across the creek from the stockyards in the headwaters of Capella Creek, just west of the Dee Range. Here it occurs with brachiopods having Givetian and Frasian affinities, and with the coral *Calceola* sp. indet, which ranges from the late Emsian into the Givetian and so the age is restricted to Givetian. This information on the age was kindly supplied by Mr. R. G. McKellar of the Geological Survey.

I thank Professor T. G. Miller of The University, Reading, and Dr. R. Tavener-Smith, The Queens' University, Belfast, for their helpful and courteous correspondence in connexion with this work; and Professor Dorothy Hill, F.R.S., for her kindness in reading the manuscript. Thanks are due also to Mr. J. T. Woods, Director of the Queensland Museum, for having photographic prints prepared for this paper.

SYSTEMATIC DESCRIPTION

Family FENESTELLIDAE King, 1850.

Genus FENESTELLA Lonsdale, 1839.

Type Species.—F. subantiqua d'Orbigny, 1850. Wenlockian, England.

Subgenus *Bajoola* subgen. nov.

Type Species.—Bajoola capellae sp. nov., Givetian, central Queensland.

Diagnosis.—Like *Fenestella,* but carina well developed, yet bearing no nodes.

Remarks.—The subgenus is proposed for those species of *Fenestella* in which the carina is strongly developed, but bears no nodes. *Levifenestella* Miller, 1961, caters for those nodeless species in which the carina is thread-like and discontinuous. Miller (1916a, p. 224) considers ". . . any departure from the 'normal' carinal condition, with a single row of nodes . . . to be of primary taxonomic significance. Thus the appearance of a double row of alternating nodes, and the appearance of dissepimental nodes, should be regarded as of generic discriminatory value." In accordance with his views, he recognized *Minilya* Crockford as a genus and erected the genera *Levifenestella* (1961b) and *Parafenestella* (1961a) for colonies which depart from the normal carinal condition of *Fenestella.* Crockford (1944, p. 172), in erecting *Minilya,* and several other authors have endeavoured to use node arrangement to subdivide the genus *Fenestella* auctt. The proposal of *Bajoola* is a further attempt to subdivide *Fenestella* into smaller and, it is hoped, more useful groups. It is not expected that *Bajoola* will be clearly demarcated in all cases from *Fenestella* or even *Levifenestella,* any more than it can be expected that *Minilya* will be. There is a hint of the transition that would be expected between *Minilya* and *Fenestella* in Crockford's (1941, p. 507) figure of *"Fenestrellina" bituberculata,* a species which she later (1944, p. 173) included in *Minilya.* The nodes in the subject of text-figure 2B tend, on the right hand branch, to be in a single series. Similarly, there probably will be found forms of carinate fenestellids with very few, irregularly spaced carinal nodes, which will be transitional between *Fenestella* s. str. and *Bajoola.*

It is apparent that *Bajoola* is not as far removed morphologically from *Fenestella* s. str. as is *Levifenestella* with its feebly developed carina, and so subgeneric rank is chosen for the new taxon.

Besides the types species, *Bajoola* is reckoned with some confidence to contain a number of other Australian species of fenestellids whose micrometric formulae are shown in Table 1.

"Fenestrellina" expansa Crockford from the Lower Permian of central Queensland, described by Crockford (1945, p. 129) as having a high, rounded carina without nodes, is a member of *Bajoola.* The variety *nodulifera,* with its slight carina and large, widely spaced nodes, cannot be considered a member of *Bajoola;* its type specimen is missing, so a suspicion aroused by text-figures 11 and 12 in Crockford's paper (1945), that the species and variety are not conspecific, cannot be confirmed. *"Fenestrellina" altacarinata* Crockford (1941, p. 507) from the Permian of New South Wales has the charactertistics of *Bajoola. Fenestella anodosa* Campbell (1961, p. 457), from the Westphalian of New South Wales is attributable to *Bajoola,* but that author's *F. stroudensis* with "weak, blunt keel, sometimes virtually absent, no nodes, and a surface covered with strong, wavy striae" is probably a *Levifenestella. "Fenestrellina" cincta* Crockford, 1948 from the Westphalian of central Queensland is another strongly carinate, nodeless fenestellid which belongs to the new subgenus.

Fenestella carinata Fenton and Fenton (1924, p. 78) is said to have a nodeless, but apparently well developed, keel. Miller (1961b), p. 494) gave *F. carinata* as a possible species of *Levifenestella,* but it may be better placed in *Bajoola.*

Fenestella (*Bajoola*) *capellae* sp. nov.

Pl. 1, figs. 1–4

Material.—Holotype, F 9821 G.S.Q. collection, Capella Creek, 34870374 Rockhampton 4-mile military sheet area. Paratypes F 10202–10206 G.S.Q. collection, same locality.

Diagnosis.—Meshwork fairly fine; fenestrule length remarkably constant; branches in many cases flexuous in plane of zoarium; obverse dissepiment surfaces carry three fine longitudinal (i.e. horizontal) ridges; branches have smooth surfaces between apertures and carry very strong, rounded carina, marked off from branch surface by sharp change of slope; no nodes; five apertures per fenestrule with stabilization of aperture at base of dissepiment; apertures arranged in opposite pairs along branches; zoecial bases narrow, oval; meshwork formula as shown in Table 1.

Description.—Largest fragment about 45 mm. high and 55 mm. wide. Zoarium fan shaped, irregularly undulose. Branches seldom straight, usually irregularly flexuous, sometimes bent quite sharply in the zoarial plane. Fenestrule length surprisingly regular, despite flexing and some crowding of branches. Fenestrules oval in obverse view, irregularly pentagonal from the rear. Obverse dissepiment surfaces set below branch surfaces, ornamented by three fine ridges. Dissepiments fairly thick, rounded, expanded at ends and short; width about 0·3 mm. Branches fairly thin, usually about same width as fenestrules. Both surfaces of branch rounded. No detectable ornamentation between apertures. Carina very strong, rounded. Base of carina up to ⅓ branch width; sharply marked off from surface of branch by abrupt change of slope. Carina bifcurcates at branch division; the two carinae arising are not as large as the parent, but gradually increase in size. Carina smooth, devoid of nodes. Apertures in two rows, usually opposite one another across the branch. Nearly always four apertures next to fenestrule, with one stabilized at each dissepiment base. Very occasionally, four or six apertures per fenestrule. Apertures do not encroach on fenestrules. One aperture in each angle formed by branch bifurcation. Apertures separated by a little more than their diameters, about 0·25 mm. apart, centre to centre. Peristomes thick, accounting for up to half the aperture diameter. Edges of peristomes touch base of carina. Some apertures show a series of short, triangular apertural septa placed inside the uppermost rim of the peristome. Zoecial bases oval, elongate and narrow, in opposite pairs along branches. Proximal tips lying just inside distal ends of preceding pair, so that long axis of oval of zoecial base is slightly oblique to branch (see pl. 1, fig. 4). Bases about 0·25 x 0·1 mm.

Remarks.—This species is rather remarkable for the regularity of its zoecial arrangement and fenestrule length, and in that the zoecia are in opposite pairs in the branches, giving rise to elongate, oval zoecial

TABLE 1

Species	B/10	D/10	Z/5	N/5	BW	ZD	Z/F	ZB
B. capellae sp. nov.	15–22	10	19–21	0	0·37–0·40	0·13	5, rarely 4 or 6	oval
B. expansa (Crockford, 1945) ..	6–7·5	3–4	10·5	0	0·5–0·9	0·24	4–10	?
B. altacarinata (Crockford, 1941)	12	6–7	22	0	0·4–0·7	0·16	4–5	?
B. anodosa (Campbell, 1961) ..	12	4–5	20–25	0	0·3–0·5	0·16–0·22	4–5	?
B. cincta (Crockford, 1948) ..	8–9	3	9–10	0	0·5–0·61	0·18	..	?

Explanation.—B/10 = branches in 10 mm. horizontally; D/10 = dissepiments in 10 mm. vertically; Z/5 = zoecia in 5 mm. along branch in single row; N/5 = nodes in 5 mm. along carina; BW = branch width; ZD = diameter of apertures; Z/F = zoecia in single row per fenestrule; ZB = zoecial base shape.

bases. In the latter respect the species is unique among the forms tentatively assigned to *Bajoola,* but I have not considered it useful to restrict *Bajoola* to forms with this character. Crockford's diagnosis (1944, p. 172) of *Minilya* restricted her genus to forms with triangular zoecial bases and node placement lateral to apertures, but, as pointed out by Elias and Condra (1957, p. 66), in practice she included in the genus forms having only the one critical feature, a double row of carinal nodes. Miller (1916a and b), in erecting the genera *Parafenestella* and *Levifenestella,* took the course which I have pursued here and characterized his genera by only one, or two closely associated, features.

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PALAEONTOLOGICAL PAPERS, No. 6

CRETACEOUS PALAEOTAXODONTIDA OF THE MARYBOROUGH FORMATION, SOUTH-EAST QUEENSLAND

by

P. J. G. FLEMING

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

Nucula gigantea Etheridge, 1872, *N. quadrata* Etheridge, 1872, *Leda elongata* Etheridge, 1872 and *Nuculana* (? *Yoldia*) *randsi* Etheridge fil., 1892, are redescribed. The synonymy of the first two is confirmed and the species is placed in *Leionucula* Quenstedt. The other two species are distinct, but belong to one genus, *Phaenodesmia* Bittner.

INTRODUCTION

The fauna of the Maryborough Formation is quite rich in bivalves, for most of which names are probably available. However, the correct application of many of the names has been in doubt because of the inadequate descriptions and figures produced by Robert Etheridge snr. (1872) in his original publication on the Maryborough fossils collected by Richard Daintree. Robert Etheridge jnr. was, it seems probable, not always in a position to assess the species names created by his father. He comments (1892, p. XVII) on having ". . . received some of the Mollusca from the Queensland Museum but they do not all appear to be there." The remark refers to the Daintree collection used by his father for his descriptions of 1872. Etheridge jnr. was the last worker to concern himself with the Cretaceous fauna of Maryborough on anything but a cursory basis, and photographs of types and detailed descriptions of the species such as are becoming more necessary have never appeared.

This is the first in a number of short papers setting out to supply detailed knowledge of the species whose types are from the Maryborough Formation. The work is concerned only with description and taxonomy, not with distribution of species, for the present.

The preservation of the fossils in the top "chert bed" of the Maryborough Formation is outstandingly good. The rocks are massive fine sandstones and mudstones and are highly silicified. Red iron oxides are often thickly deposited in the cavities left by leaching of shell carbonate, but are easily removed by boiling in dilute strong acid without harm to the moulds. Most of the shells have suffered little by pre-burial damage, but are sometimes distorted, apparently by earth movements.

In this paper, *Nucula gigantea* Eth., 1872, *N. quadrata* Eth., 1872, *Leda elongata* Eth., 1872 and *Nuculana* (? *Yoldia*) *randsi* Eth. fil., 1892 are redescribed from type and other material. The synonymy of the first two, suspected by Etheridge jnr. and Professor R. Tate (Eth. jnr., 1902, p. 24) is confirmed, and it is considered that the name *quadrata* should be used. *Leda elongata* and *Nuculana randsi* are considered to be two distinct species and are referred to *Phaenodesmia* Bittner.

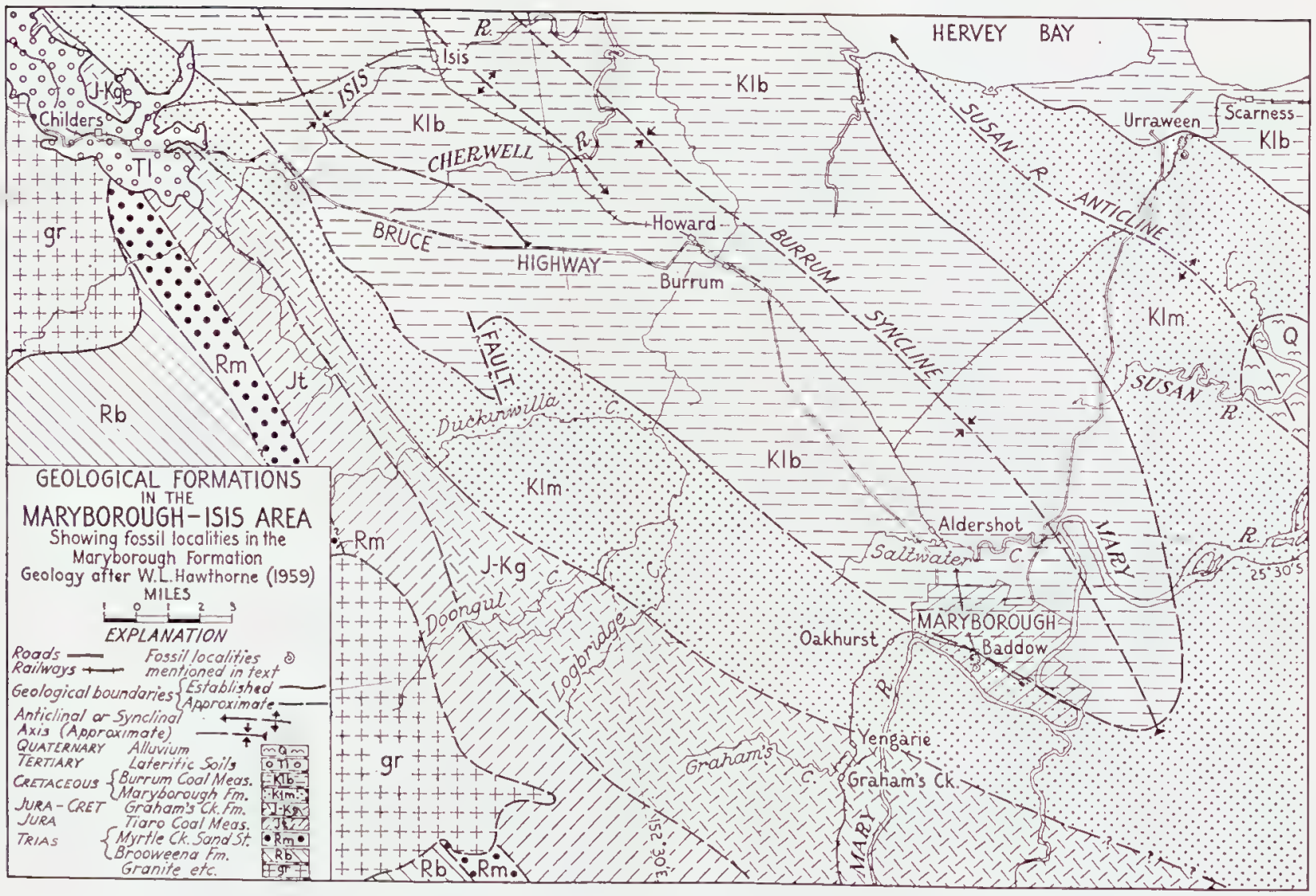
Acknowledgements.—Thanks are due to the Director of the Queensland Museum, Mr. J. T. Woods, for the loan of type material and for helpful criticism and advice. Mr. H. O. Fletcher, Deputy Director of the Australian Museum, kindly supplied for examination a large suite of specimens of *Nucula obliqua* Lamarck. Professor Dorothy Hill, F.R.S., has given helpful advice during the preparation of the work.

LOCALITIES

The locality given by Etheridge (1872) for the Nuculas and *Leda elongata* is "Maryborough". The type locality may therefore be taken as the area in and about Maryborough city, and the topotypes used in the present descriptions have been taken from collections of the Geological Survey made over fifty years ago by W. H. Rands and B. Dunstan. These collections were made at Corporation Quarry, Maryborough, which has also been known by the name Baddow Quarry, and is near the place once called Croydon Junction. The type locality of *Nuculana* (? *Yoldia*) *randsi* is at the crossing of the Maryborough–Bundaberg highway over the Isis River, and, since no more material has become available from there, the description given here is based on the holotype and material from Corporation Quarry and Urraween railway siding. The accompanying map shows the various localities.

AGE OF THE SPECIES

The most recent published work on the stratigraphy of the Maryborough Formation is in Hill and Denmead (1960). The formation is at present correlated with the Aptian Roma Formation because of the general similarities of the faunas and the presence of *Australiceras* in the Woody Island exposures of the Maryborough Formation. Although the faunas of the



formations bear general similarities, there are also considerable differences, and there may be an age difference between Roma and Maryborough. The Maryborough Formation is at present being remapped by the G.S.Q. As the Maryborough fauna is studied in more detail, a clearer understanding of its relationship to the Roma Formation fossils should be possible.

The Maryborough Formation is as much as 6,000 feet in thickness and so far no species from any but the top chert bed have been described. It may even be that there is a significant age difference between the top and bottom of the formation, although preliminary examination of collections from near the base seem to suggest correlation with the Aptian of the Great Artesian Basin. Outcrop of all but the top chert bed is poor, and very few fossils have been collected from the lower horizons. A detailed examination of the lower faunas will be undertaken in due course.

TAXONOMY AND DESCRIPTIONS

Leionucula quadrata (Etheridge, 1872)

Pl. 2, figs. 1–5; Pl. 3, figs. 1–5.

1872 *Nucula quadrata* Eth., p. 341, pl. 19, fig. 5; pl. 20, fig. 3.
1872 *N. gigantea* Eth., p. 341, pl. 20, fig. 4.
1892 *N. quadrata* Eth. Eth. fil., p. 565, pl. 26, figs. 8–9.
1892 *N. gigantea* Eth. Eth. fil., p. 566, pl. 26, figs. 6–7.
1902 *N. quadrata* Eth. Eth. fil., p. 23, pl. 3, figs. 13–14.

Diagnosis.—Large nuculid, moderately inflated, marginal outline oval, umbos little elevated above hinge margin; ornament of fine growth lines; anterior and posterior adductors fairly equally developed; accessory musculature consists of elongate scar descending from umbonal cavity to level of anterior adductor scar; between anterior adductor and lower end of umbonal scar, two small circular accessory muscle scars in left valve and three in right valve; hinge with strong antero-ventrally directed chondrophore; anterior series of teeth as in *Nucula;* posterior series with small lamellar teeth behind chondrophore tooth which borders chondrophore in left valve; chondrophore tooth of right valve placed behind that of left in closed position.

The Queensland Museum's specimen F 17/1245 is chosen as lectotype of this species, in the absence of nomination of a type by its author, since it is surely the right valve figured by Etheridge (1872, pl. 20, fig. 3). The other specimen which could be chosen as lectotype, F 17/1246 (Queensland Museum), is not as surely the original of Etheridge's pl. 19, fig. 5.

With F 17/1245 selected as lectotype, the left valve not figured by Etheridge and which is not distorted becomes available to give a more secure basis for the species.

The left-hand drawing of Etheridge's pl. 20, fig. 3 remains a mystery. It may be an antero-lateral view of F 17/1245, but if so, it is not a faithful reproduction by any means.

Dimensions (mm.):—

	Length	Height	Breadth
F 17/1245 ..	38	28 (at umbo)	19
F 17/1246 ..	35	27 (just behind broken umbo)	17

Description of lectotype

F 17/1245. Specimen is internal mould of both valves in contact. No teeth can be seen. Thick chondrophore in each valve. Adductor scars erectly oval, deeply impressed under ends of hinge-line. Pallial line entire. Inflation fairly strong (see dimensions, above). Umbonal cavity quite deep. Internal mould slightly concave on umbonal slopes. Umbo not inrolled, moderately opisthogyrous. Posterior margin more sharply rounded than anterior. All margins smooth curves, without sinuses. Vertically elongate, impressed muscle scar about 1 mm. in front of umbo, extending down from the umbonal slope. Three roughly circular scars are horizontally disposed between the vertical scar and the anterior adductor. The top of the vertical scar and its relation to the top of the umbonal slope eroded away. Strong thickening in front of the posterior adductor, extending below adductor to pallial line. No pallial sinus. Interior of ventral margin smooth.

There is no indication of Etheridge's (1872, p. 341) "posterior side much elongated and sharply rounded", nor any indication of teeth. F 17/1246 is probably Etheridge's pl. 19, fig. 5, but the umbo is broken off. The specimen shows no more than F 17/1245 and is conspecific with it.

The type of "Nucula gigantea"

Although Etheridge (1872, p. 341) said only one specimen of "*N. gigantea*" occurred in the collection before him, two specimens appear in his pl. 20, fig. 4. An examination of the specimens, on a piece of rock numbered F 17/1244, Queensland Museum collection, shows that Etheridge's description could have referred to only one of the specimens, because of the features it shows. The specimen is the lower of the two in pl. 20, fig. 4 and it must be taken as the type. It shows no features of musculature, no pallial line, seventeen anterior, and four or five posterior, teeth. The umbo is flattened onto the hinge and the lower margin is split radially by lateral compression. The marginal shape is oval and the shell thin.

The following specimens (G.S.Q. collection from Corporation Quarry) are considered to be conspecific with the type:—F 6811, F 6815, F 6827, F 6829, F 6833, F 6834, F 6841, F 6859, F 6874, F 6891, F 6893, F 6897, F 6905.

Description of topotypes

Ornament.—Consists of fine growth lines. No lunule or escutcheon seen in available material.

Shape.—Umbo about one-third shell length from the rear. Marginal outline almost oval except for posterior margin which curves a little too sharply, marring the oval. Thickening under hinge plates varies. Umbonal slopes only slightly to quite strongly concave in lateral view depending on the degree of thickening. F 6827 — F 6815 — F 6834 — F 6829 is a series showing decreasing degree of this thickening. This is important in considering the relationship between this species and the holotype of *N. gigantea.*

Musculature.—Best preservation is in F 6815 which is the internal moulds of two valves of the one individual slightly separated. A vertically elongated impressed muscle scar in front of and below the umbo bends up and back and is seen to originate in the point of the umbonal cavity. In F 6815, the vertical part of this scar is 5 mm. long and the inclined part 6 mm. long. The right valve has three closely spaced, round, impressed scars occupying 4 mm. The posterior of these is 2 mm. from the bottom of the vertical scar; the anterior is 2 mm. from the posterior edge of the anterior adductor. The posterior scar is the largest and the anterior the smallest. Left valve has only two, about equal in size, 1 mm. apart, 3 mm. from adductor, 2 mm. from vertical scar. Anterior adductor strongly impressed, but thickening behind it slight.

Hinge.—Number of teeth varies. F 6815, left valve, has seventeen anterior teeth, eleven behind chondrophore pit. F 6834, right valve, seventeen anterior teeth, eight behind chondrophore tooth. Chondrophore long, directed antero-ventrally, thick as shown in the type F 17/1245 and all other specimens. Up to nearly 5 mm. long in larger specimens. Contiguous for most of its length with anterior hinge plate, no ridge separating border of chondrophore from teeth. Up to 1·8 mm. wide at widest part. Thickened behind, beneath posterior tooth row. Bordered nearer cardinal margin in left valve by low chondrophore tooth; in right valve by flattened area which receives chondrophore tooth of left valve. Posterior tooth row:—Hindmost five or six teeth are normal nuculoid with points of chevrons directed toward umbo. Teeth just behind chondrophore tooth are thin and mis-shapen—four in left valve, three in right. Foremost of these in left valve is stronger than other three. None have definite chevron shape. In right valve the foremost of the three has in front of it the thick tooth (chondrophore tooth) which fits behind the chondrophore tooth of the left valve into the chondrophore tooth socket. The flat border of the chondrophore of right valve lies in front of the thick tooth and the pit behind the thick tooth receives the strongest of the mis-shapen teeth of the left valve. Anterior tooth rows start in angle between chondrophore and cardinal margin and teeth increase evenly in size to number fourteen or fifteen forward. Chevrons point to umbo. Preservation of some specimens is so good that the remains of the juvenile teeth described by Bernard (1896) can be seen.

Affinities

The species falls in the group of Nuculidae with non-denticulate margins (Schenk, 1934) and bears close resemblance to the type of *Ennucula* Iredale, 1931, as described and figured by Schenk. The type of *Ennucula,* by original designation, is *Nucula obliqua* Lamark from southern Australian waters. The type of that species is housed in the National Musuem of Natural History in Paris, but I have been able to examine, by courtesy of Mr. H. O. Fletcher of the Australian Museum, a large number of specimens of *obliqua.* In shape, musculature and hinge structure, *quadrata* Etheridge is very closely similar to the specimens of *Nucula obliqua* and is considered congeneric with them. The specimens of *obliqua* are all much smaller than any of the specimens of *quadrata* that I have seen from Maryborough and the hinge of *obliqua* is somewhat more simplified by having fewer of the mis-shapen teeth behind the chondrophore. These teeth are also not as thin or as strongly malformed as in the Cretaceous species, nor is the chondrophore tooth as strongly differentiated as in *quadrata.*

Schenk (1934, p. 35) suspected a close relationship between *Ennucula* and *Leionucula* Quenstedt, 1930 whose type species is *Nucula albensis* d'Orbigny from the Cretaceous of Europe. Schenk did not see the hinge of this species until after his work had gone to press and in a footnote gives the following brief description of the hinge of a left valve. "The arched anterior row of teeth has about twenty-five teeth; the straight posterior series about ten. A chondrophore tooth is present; the chondrophore is oblique." The similarity of size and shape and the presence of the chondrophore teeth place *Ennucula* and *Leionucula* very close together and I am led to believe that they are to be treated as synonyms in the Treatise on Invertebrate Paleontology.

Nucula quadrata Etheridge, 1872, therefore, may be assigned to the genus *Leionucula* which occurs in the Cretaceous and Recent of the eastern Australian region.

Relationship of quadrata *and* gigantea

Etheridge (1902, p. 24) was of the opinion that the two species were synonymous and alluded to Professor R. Tate's similar opinion. The types of the two are of different aspect, but the difference is readily explained after an examination of a considerable number of specimens from Corporation Quarry, which reveals that there is a good deal of variation in shell thickness. Specimens with musculature deeply impressed into a thick shell have been only a little or not at all compressed in fossilization; but those with thin shells have been pressed almost flat and the moulds of their umbonal cavities now lie hard against the hinge line. A series can be selected showing a complete gradation between the type of *quadrata* and that of *gigantea.* The greater the flattening of the shells the weaker is the musculature and the wider are the radial cracks around the ventral margin which do not occur at all in thick-shelled specimens of *quadrata.* All the specimens from Corporation Quarry, whether thin or thick shelled, have the same hinge structure and marginal shape and all are of comparable size.

Etheridge jnr's. suspicion (1902, p. 24) that *gigantea* is a synonym of *quadrata* is confirmed, and it is suggested that the name *quadrata* should be used since the type material of *quadrata* is much more useful than that of *gigantea.*

Phaenodesmia elongata (Etheridge, 1872)

Pl. 4, figs. 1–8

1872 *Leda elongata* Eth., p. 341, pl. 20, fig. 5.
? 1892 *Adrana elongata* Eth. Eth. fil., p. 566.
? 1902 *Malletia elongata* Eth. Eth. fil., p. 26, pl. 3, figs. 21–24; pl. 6, fig. 14.

Diagnosis.—Medium to fairly large sized nuculanaceans with ornament of fine concentric rugae; moderately inflated, postero-dorsal region compressed, anterior and ventral margins rounded, posterior slightly truncate, producing an angular appearance of the postero-dorsal extremity; top of umbonal cavity higher than hinge line; dorsal margin behind umbo fairly strongly concave. Narrow escutcheon present; carina not strong. Hinge teeth small, in a continuous row, becoming minute under umbo. Pallial sinus wide and fairly deep.

Holotype

F 17/1247 Queensland Museum collection, the only specimen figured by Etheridge. Less of the specimen was exposed than was indicated by Etheridge's figure. All the preserved part of the fossil has now been exposed.

Description of Holotype

Broken before burial along a line from about front of anterior tooth row to back of ventral margin. 16·5 mm. long, 8 mm. high, 2 mm. in inflation. Originally it would have been 20 mm. or more long and about 10 mm. high.

Top rear margin sharply rounded on radius of 1 mm. or less. Posterior margin drops vertically from this rounding and then curves evenly toward venter on 6 or 7 mm. radius. Umbo 1 cm. from posterior end, almost erect, very slightly prosogyrous. Hinge margin nearly straight, but slightly arched up under umbo. Top of umbonal cavity about 0·5 mm. above hinge line. Umbonal slopes in mould concave. Moderately inflated, compressed in rear dorsal region. Very slightly rostrate, but apparently not carinate, on rear dorsal margin. No indication of siphonal gape.

Hinge plate narrow, but distinctly formed. Rear end of tooth row 3 mm. from back end of shell. Teeth broken from beneath umbo, but fairly definitely no chondrophore. Hinge plate under umbo continuous. Sixteen teeth from back and about fourteen from front are present. Broken away 1 mm. in front of umbo and 2 mm. behind. Chevrons point to umbo from both posterior and anterior row. Anterior row 5·5 mm.

long, posterior 7 mm. Musculature and pallial line not preserved. A trace of concentric costation is left below and about 4 mm. behind the umbo.

The following topotypes are used as the basis for further description:—F 7127, F 7130, F 7136, F 7149, F 7157, F 7435, F 7437, F 7442. They are G.S.Q. collection material from Croydon Junction.

Description of topotypes

Shape.—Anterior evenly rounded from umbo to venter directly beneath umbo. Venter very broadly rounded. Posterior truncate in appearance at about 60° to horizontal. Postero-dorsal corner sharply rounded on radius of 1 mm. or less. Dorsal margin slightly arched along tooth rows, slightly upturned behind end of posterior tooth tow. No distinguishable gape. Moderately inflated, postero-dorsal region flattened. Umbonal cavity projects 0·5 mm. or so above hinge line, slightly prosogyrous. Umbonal slopes slightly concave or almost straight in mould. Very slight rostration, without sharp carination, along front part of postero-dorsal margin.

Ornament.—Consists of fine, rounded concentric costae separated by flat interspaces usually wider than the costae. On F 7442 there are about thirty costae in 5 mm. They vary from less than 0·1 mm. to 0·3 mm. apart and are as fine as 0·05 mm. wide. On F 7136 the costae are more regular in size and spacing. No topotype specimens showing an escutcheon are available, but F 9318 from a cutting near Urraween railway station has a narrow, lanceolate escutcheon.

Musculature.—Anterior adductor under and against end of hinge plate. Posterior edge of it vertical, 2 mm. high, anterior edge rounded. Posterior adductor horizontally elongate, under and against, but not reaching end of hinge plate, about 3mm. long, 1 mm. high. Pallial sinus wide and deep, extends to half way between umbo and posterior adductor. Pallial line from anterior adductor along anterior and venter not visible on topotypes. Accessory muscles not distinct, but appear to be in two bands extending forward and down from the rear umbonal slope, the posterior band being the shorter.

Hinge.—About eighteen anterior teeth, thirty posterior in small specimens, twenty-five and forty in larger specimens. Chevrons pointing to umbo from front and back. Teeth arch up slightly under umbo where they are very minute. Not interrupted. Increase evenly in size away from umbo. Hinge plate wide (horizontally across shell) under umbo. No chondrophore.

Dimensions (mm.):—

	Length	Height	Breadth
F 7127	23	10·5	3
F 7149	21	12	4
F 7157	22	10·5	4

Affinities of elongata *and relationship to* "Nuculana" randsi

Leda elongata was discussed by Etheridge jnr. under the generic designations *Adrana* and *Malletia,* and *Nuculana* (*?Yoldia*) *randsi* was placed in its synonymy in 1902. Etheridge had little chance of determining the affinities or, indeed, even any characters of this species, from the meagre description and poor figure of the type specimen. By his remarks (1902, p. 26) it seems that he had never seen the type.

Leda elongata is here assigned to *Phaenodesmia* Bittner, 1895. Further comment on this assignation is to be found under the discussion of the affinities of *Phaenodesmia randsi.*

When first looking through the Maryborough collections, I distinguished a *Nuculana*-like form with a characteristically shaped posterior and fine concentric costae from the larger, smooth forms which were apparently *Nuculana randsi.* However, it was not until the type of *Phaenodesmia elongata* was very carefully studied that the specimens with fine concentric ornament could be named, for the type specimen required considerable preparation and careful lighting before it yielded sufficient information for other specimens to be identified with it. The features of the type enabling topotypes to be selected are:—hinge structure; the shape of most of the dorsal margin and all of the posterior; the shape of the umbonal region; and the concentric ornament which has been impressed apparently as the effect of composite moulding and which can be seen under very oblique, strong light when magnesium oxide smoke is applied.

Phaenodesmia elongata is regarded as distinct from *P. randsi* and the distinctions will be discussed in detail under the section on the relationship of *elongata* and *randsi* after the description of the latter.

Phaenodesmia randsi (Etheridge fil., 1892)
Pl. 4 figs. 9–13

1892 *Nuculana* (*?Yoldia*) *randsi* Eth. fil., p. 566, pl. 26, fig. 10.
1901 *Malletia randsi* Eth. fil., p. 25.
1902 *Malletia elongata* Eth. Eth. fil., p. 26, *partim.*

Diagnosis.—Large, moderately inflated nuculanceans with ornament of only rather weak growth lines; anterior, ventral and posterior margins smoothly rounded, posterior much more sharply than anterior; posterior part of dorsal margin sloping down to rear along whole of length; tip of umbo very little higher than hinge margin; rather broadly rounded carina originating behind umbo and ending before posterior margin; carina limits escutcheon which is fairly narrow, lanceolate and diagonally ornamented; adductor scars fairly small, set against hinge line; pallial sinus wide, but not very deep, pallial tongue rounded; hinge with nearly as many teeth in front of umbo as behind; hinge plate well developed; teeth very small and not interrupted under umbo.

Holotype

F 1410, G.S.Q. collection from Isis River, near Bundaberg–Maryborough road. Etheridge jnr. (1901) decided that the type specimen was not perfect and the illustration of it gives "by no means. . . a correct idea of the shell". However, the holotype is a reasonably complete internal mould, very slightly crushed, enough only to affect the inflation as Etheridge jnr. himself implied (1901, p. 26). The holotype has a fairly short posterior end compared with some other specimens, but by no means all, and this has nothing to do with its state of preservation. It has been weathered, but details of musculature are still observable. In my opinion, the species is readily interpretable from the type specimen.

Description of holotype

Dimensions (mm.):—

Length	Height	Breadth
30	18	5

Shape.—Anterior margin smoothly rounded, posterior sharply rounded on radius of 2 mm. Venter smoothly curved between the two. Dorsal margin in front of umbo convex upwards, behind umbo concave upwards, but sloping downwards to the rear for its whole length. Point of umbonal cavity at same height as cardinal margin. Fairly strongly inflated except for postero-dorsal region which is flattened. Perhaps slight gape high at posterior end. Umbonal slopes concave in mould. Point of umbo 14 mm. from anterior end, 16 mm. from posterior. Could be slightly rostrate.

Musculature.—Posterior adductor oval, horizontally elongate (3 mm. long), lying under end of tooth row. Front of anterior adductor under front end of tooth row, length vertical (2–3 mm.). Pallial line from base of anterior adductor scar to directly below front of posterior adductor where it curves to pallial sinus. Sinus smooth curve from lower front of posterior adductor. Smooth curve from sinus to anterior part of pallial line at tongue. Sinus extends to a third of the distance between posterior adductor and umbo. One area of depressed accessory muscle scar extending forward and down from rear umbonal slope. All musculature weakly impressed. Considerable area below umbo eroded.

Hinge.—No chondrophore. Length 11 mm. in front of umbo and 12 mm. behind. More than fifteen anterior teeth, number of posterior teeth not able to be counted. Chevrons point to umbo. Hinge plate strong and wide under umbo; deep, but not wide anteriorly; wide at rear, but not as deep as at anterior end.

No topotype material of this species has become available. The Bundaberg–Maryborough road crosses the Isis River just east of the outcrop of the uppermost bed of the Maryborough Formation. It can be reasonably assumed that the locality of the holotype is in the top chert beds of the Maryborough Formation which outcrop about two hundred yards upstream from the bridge. The material used for the rest of the description of *randsi* is from the top chert beds of the Maryborough Formation at Corporation Quarry and Urraween railway station. The material is well preserved and is confidently identified as conspecific with the type.

The specimens used are all G.S.Q. collection material. Their numbers are:—F 7129, F 7146, F 7153, F 7425, F 7439, F 7441, F 7526a, b—from Corporation Quarry; F 9319, F 9320—from Urraween railway station.

Additional description

Ornament.—F 7526b, F 9319 and F 9320 show exterior. Growth lines only body ornament. Escutcheon narrow, lanceolate, ribbed obliquely. Ribs faint, about 0·1 mm. wide and same distance apart, running obliquely backward at about 25° to the hinge. Escutcheon about same length as posterior tooth row, bordered by blunt carina. Escutcheon depressed more at front than at rear. No lunule.

Margins.—Posterior marginal shape varies from small curvature as in holotype to larger curvature of about 3–4 mm. radius as in F 7153. Upper margin almost straight to back end in some (e.g. F 9319), curving down near end in others (e.g. F 7425).

Musculature.—Adductor musculature and pallial line shown by F 7153 and F 7425—same as in holotype. F 7425 has an accessory muscle scar extending down and forward from just in front of the umbo.

Hinge.—F 7425 shows the hinge almost perfectly. More than twenty anterior teeth, twenty-three posterior teeth. No interruption to tooth row or hinge plate. No chondrophore. Anterior tooth row 10 mm. long, posterior row 12 mm. In the larger F 7153, the anterior row is 12 mm. long and has twenty-three teeth and the posterior row is 17 mm. long and has more than twenty-five teeth.

Relationship of randsi *and* elongata

Etheridge (1902, p. 26) commented thus:—"The figure of *Leda elongata,* Etheridge, was, it is almost certain, drawn from an imperfect specimen; hence I have for a long time been in a state of indecision as to its relation to *Nuculana randsi,* mihi. A reconsideration of the subject, however, by the light of a large number of specimens of the latter in different states of preservation has convinced me that the two names must be merged in one, Mr. Etheridge's specific name having precedence". That decision is revoked here and *elongata* and *randsi* are regarded as separate and distinguishable species, with certain constant and distinct points of difference between them, the most important of these being marginal shape and ornament. Etheridge's (1901, p. 25–26) remarks in his discussion of *Malletia randsi* seem to suggest that he was at that stage confused by a failure to distinguish the two species, thinking that features of certain shells (with "upward curvature of the cardinal margins") were merely variations from the type of his species *randsi* and that his figure of the type, because of the imperfection of the shell, did not give a correct idea of the

species. In fact, the type of *randsi,* although only a weathered internal mould, provides an excellent guide to the species, for the weathering process has not destroyed the characters of the specimen. There is, as far as I have been able to tell in examining collections from the Maryborough Formation, no significant gradation between *elongata* and *randsi,* any specimen, provided there are enough features preserved, being readily assignable to one or other species.

The species *elongata* and *randsi* may be distinguished reliably by their differences in ornament, marginal shape, height of umbo, size of escutcheon and depth of pallial sinus. The ornament of *elongata* consists of fine, rounded, concentric and very distinct costae, while *randsi* is always smooth or has growth lines only. The swept-up appearance of the posterior of *elongata* is easily distinguished from the more evenly tapering, rounded posterior of *randsi.* The mould of the umbonal cavity of *elongata* projects above the hinge margin, but that of *randsi* is typically at the same level. The escutcheon of *randsi* is wider and more deeply impressed than the escutcheon of *elongata.* The pallial sinus of *elongata* is deeper than that of *randsi.*

Affinities of randsi

This species, like *P. elongata,* is remarkable for its *Nuculana*-like aspect combined with its *Malletia*-like hinge without a chondrophore. The absence of a chondrophore is quite firmly established by the well preserved specimens in the G.S.Q. collection. The shell is *Nuculana*-like not only in general shape, but also in being rostrate and carinate, the low carina marking off a depressed and strongly striated escutcheon.

For this type of shell, which combines the hinge of Malletiidae with the shape of Nuculanidae, Bittner (1895) proposed the generic name *Phaenodesmia.* It is suggested that Bittner's genus is a suitable category for the two Maryborough species, *elongata* and *randsi.* Bittner's figures of *Phaenodesmia* (1895, pl. 18) show mild rostration and the presence of an escutcheon.

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PALAEONTOLOGICAL PAPERS, No. 7

THE BIVALVE *GRAMMATODON* (*INDOGRAMMATODON*) COX IN THE LOWER CRETACEOUS OF QUEENSLAND

by

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GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

Cucullaea robusta Etheridge, 1872 is redescribed. The synonymy of the species with *C. costata* Eth., 1872 is confirmed and it is placed in the subgenus *Grammatodon* (*Indogrammatodon*) Cox, 1937.

INTRODUCTION

This is the second in a series of short papers revising the described fauna of the Maryborough Formation of the Maryborough Basin, south-east Queensland. The first paper deals with the known palaeotaxodontids and appears with this paper in Publication 333.

Cucullaea robusta Etheridge, 1872 and *Cucullaea costata* Etheridge, 1872 are dealt with in this paper. It is considered that the two are synonyms, and it is proposed that the name *robusta* be used, the course followed by Etheridge jnr. (1892, p. 565) who may not have seen the type specimens.

It will be shown after the descriptions of the types and topotype material from the Maryborough Formation that *C. robusta* belongs to *Indogrammatodon* Cox, erected in 1937 as a subgenus of *Grammatodon* Meek and Hayden.

The distribution of *Indogrammatodon* as summarized from Cox (1940) is as follows. The type species, *Cucullaea virgata* J. de C. Sowerby, 1840 occurs in the Jura of India and east Africa. The most widely distributed species. *Indogrammatodon egertonianus* (Stoliczka) occurs in the Upper Jura of Arabia, Somaliland, east Africa, New Zealand and northern India. The subgenus is also thought to occur in the Toarcian of France and perhaps the Upper Cretaceous of Palestine. The type species has been recognized in the Upper Jura of Papua by Glaessner (1945).

Cox pointed out the similarity of the external characters of *C. robusta* and *C. virgata* and the description of the hinge of the former now confirms the occurrence of *Indogrammatodon* in the Lower Cretaceous of Queensland.

Acknowledgements.—The Director of the Queensland Museum, Mr. J. T. Woods, kindly lent type material and gave much helpful criticism. Professor Dorothy Hill, F.R.S., has helped greatly during the preparation of the work.

MATERIAL

The specimens described and figured in this paper are from the collections of the Queensland Museum and the Geological Survey of Queensland. The specimens from the Daintree collection now housed in the Queensland Museum are the original material used by Etheridge snr. and were probably collected at or near Maryborough, in the Maryborough Formation (see section "Localities" in Palaeontological Papers, No. 6, in this Publication).

DESCRIPTIONS

Grammatodon (*Indogrammatodon*) *robusta*
(Etheridge, 1872)
Pl. 5, figs. 1–5, Pl. 6, figs. 1–4

1872 *Cucullaea robusta* Eth., p. 340, pl. 20, fig. 1.
1872 *C. costata* Eth., p. 340, pl. 20, fig. 2.
1892 *C. robusta* Eth. Eth. fil., p. 565, pl. 26, figs. 1 and 4.
1902 *Idonearca? robusta* (Eth.) Eth. fil., p. 27.

Diagnosis.—Shell large when mature, of general arcoid form, moderately elongate, but with a high umbo; inequilateral; posterior carina obscure; umbos high, broad and fairly strongly incurved, but not meeting; tumidity of shell about equal to height; triangular ligament areas very high and strongly concave, bearing numerous fine chevron-shaped ligament grooves; pallial line entire; interior surface of shell below pallial line convex; hinge straight, equipped with three or four horizontal anterior, and the same number of posterior, teeth; toward point of hinge under umbo, teeth progressively become more nearly vertical, more abruptly in anterior than in posterior part; all teeth transversely ridged and grooved in dendritic patterns, but summits of teeth not affected; ornament of sharp radial ribs crossed by numerous fine growth lamellae, ribbing of right and left valves not corresponding; strong primary ribs on both valves, but interspaces in right valve crowded with second, third, and occasionally fourth order intercalated finer ribs, usually only one or two intercalated ribs between primaries in left valve; ribs very weak on and above carina.

The type specimen is housed in the Queensland Museum and numbered F 17/1242. It is a slightly distorted internal mould of a left valve with the mid-region of the hinge line broken a little and the antero and postero dorsal corners broken off. The specimen is considerably flattened laterally.

Description of holotype

Dimensions (mm.).—

Length	Height	Breadth (single valve)
55	36	18

Shape.—Hinge margin probably straight, although a little distorted in preservation. Anterior margin slopes back away from antero dorsal corner, broadly rounded, passing evenly into ventral margin which is very broadly rounded. Top of posterior margin not present; curvature of rear probably sharper than of front. Original inflation higher than in present condition; now moderately inflated for Arcacea. Tip of umbo vertically above hinge margin as preserved. Umbo a little prosogyrate, whole shell markedly prosocline. Umbo moderately inrolled, but probably not as far in life as in present condition. Ligament area now very strongly concave. Carinate anterior and bicarinate posterior umbonal slopes—could be entirely due to distortion.

Ornament.—Ventral marginal region along flank shows trace of seven broad but very shallow plicae. No such traces on anterior and posterior slopes.

Musculature.—No traces of muscular impressions are visible. However, a change from concave to convex inner curvature of the shell occurs about seven millimetres from the margins and probably indicates the position of a non sinuated pallial line.

Hinge.—Although broken away at the anterior and posterior tips and broken below the umbo, the characters of the hinge can be clearly seen. The teeth near the extremities are almost parallel to the hinge margin. There are four horizontal teeth at the posterior end and probably three (three are clearly preserved) at the anterior. The teeth directly beneath the umbo are short and vertical as in *Arca*, but only very few (perhaps two or only one in number). Between these and the anterior horizontal teeth there are teeth of intermediate slope, becoming more nearly horizontal anteriorly. They are not clearly preserved. A long, narrow, almost horizontal tooth lies immediately in front of and above the highest of the posterior horizontal teeth. Between this and the umbo there are traces of four teeth, the foremost of them being almost vertical and the others of intermediate obliquity. The teeth are wedge shaped and have minute dendritic crenellations in bands midway between the bases of the sockets and the crests of the teeth, along both sides of the teeth. The crenellations are perpendicular to the length of each tooth.

The hinge teeth, although not preserved well enough for precise counting of their number, are sufficiently well preserved to show that the essential characters of the hinge are those of *Grammatodon* Meek and Hayden.

Ligament.—An impression of a piece of the area of a shell, perhaps belonging to the same individual, is situated near the hinge of the type specimen. The ligament grooves are very fine, about ¼ of a millimetre wide, and the area very wide by comparison. However, there is no certainty that it does belong to the type.

The type of "Cucullaea costata"

Etheridge's figured specimen is numbered F 17/1243 in the Queensland Museum collection. It is a very badly preserved internal mould of the two valves and the characters shown by it are not sufficient to place it with certainty in a genus. It is 46 mm. long, 30 mm. high and each valve is about 19 mm. in breadth. A few of Etheridge's remarks require comment:—The "small portion of the shell which remains" is only the iron oxide skin of the mould. There is no definite evidence for lack of a pallial sinus, the remains of only eight ribs can be seen, and the "transverse costae between the ribs" are very faint impressions of fine concentric ornament like the lamellae in specimens of *I. robusta.* The species was declared to be "abundantly represented in these rocks", but there are, at least now, no other arcoid specimens in the Daintree collection, apart from the type of *I. robusta.*

There is no evidence to suggest that the specimen is not conspecific with the type of *I. robusta* which it resembles in shape and the few other features observable.

The following specimens (G.S.Q. collection) are used for further description. They are from Corporation Quarry and two of them were figured by Etheridge jnr. (1892). F 1402, pl. 26, fig. 1; F 1403; pl. 26, fig. 4). F 1402, F 1403, F 7034, F 7036, F 7038, F 7039, F 7041, F 7044, F 7047, F 7048, F 7051, F 7053, F 7054, F 7415, F 7416, F 7472, F 7474, F 7487. F 5472 (Q.M. collection) is a very good internal and external mould of a complete specimen. Its locality is Maryborough.

Description of topotypes

Dimensions (mm.).—

	Length	Height	Breadth (single valve)
F 1402	>80	45	18
F. 1403	34	22	10

Shape.—Many of the mentioned specimens are distorted and most are incomplete, but F 7051, F 7047, F 1402 and F 1403 are nearly complete and apparently little distorted.

The hinge margin is straight and its anterior end is at the anterior extremity of the shell. Its posterior end does not extend as far back as the postero-ventral margin at the end of the carina. Anterior margin slopes back and down from the anterior end of the hinge margin, meeting the broad ventral margin in a smooth curve. The upper part of the posterior margin is almost parallel with the upper anterior margin. A sharper, but smoothly curved portion separates ventral and posterior margins. This portion is at the end of a fairly wide, low, posterior carina running back from the umbo. The shell is strongly inflated, but flattish above the carina, its umbos widely separated and the ligament area wide. Umbos are high above the hinge margin. Byssal gape not in evidence; very narrow if present.

Ornament.—Consists of radial costae of more than one order of strength crossed by fine concentric lamellae. Differs on various areas of the shell and is different on right and left valves of any particular individual.

Left valve:—Strong primary ribs raised on anterior flank to 1 mm. above inter-spaces. 6–7 mm. apart near ventral margins of mature specimens. No specimen shows all ribs, but probably about twelve primary ribs between anterior and carina of shell. Ribs on and above carina very feebly developed, and about five or six in number of primaries. Secondaries here are very fine indeed, readily observable only under oblique light.

Secondary ribs usually developed over anterior and lateral parts of shell. Insertion by intercalation well below umbo. Occasionally one or more on any shell is as strong as the primaries, in which case it originates higher on the shell. Occasionally on larger shells tertiary ribs, much thinner than secondaries, may be present. They originate by intercalation not earlier than one-third of the shell height from the umbo. There may be very fine ribs of a fourth order in large individuals back near the carina.

Ribs are crossed by fine, regular concentric laminae which make the ribs discontinuous. There are about five laminae per mm., and at irregular, but frequent intervals, some laminae are further raised from the underlying shell than the remainder of the laminae, as is usual in laminated shells with growth interruptions.

Right valve:—Most remarkable feature is that the ornament differs from that of the left valve in that it is usual for there to be multiple, fairly evenly developed ribs between the large primary ribs. There are about thirteen strong primary ribs between the anterior margin and the lateral portion of the shell bordering the postero-lateral carina. As in the left valve, the density of spacing is slightly greater in the mid-region than at the back, and especially the front. Strength of primary ribs decreases toward the rear. Up to five ribs of much smaller, but fairly regular size occur between the primaries, in contrast to one and sometimes three of unequal size between the primaries of the left valve. The ornament of the shells is not as clear near the umbos as on younger parts. This is thought to be due to pre-fossilization effects, perhaps abrasion or solution. Because of this it is difficult to precisely determine the origins of the intercalated ribs on the right valve. However, the number of intercalated ribs varies from three to five, often the ones nearest the primaries being set on the slopes of the primaries. There appear to be secondary, tertiary and quaternary ribs present, with a possibility of very feebly developed fifth order ribs on some larger shells. The intercalated ribs at the front of the shell are very weak, but still up to five in number. There are about five weak primary ribs over the carina and the area above it, with multiple fine ribs between these primaries. The concentric ornament crossing the ribbing is the same as in the left valve.

Musculature.—The surfaces of the interior of all the shells, except for composite moulding showing external ornament, are smooth and show no features of the musculature except a hint of the position of the pallial line. The interior of the shell is generally concave, but a line marking a change of curvature occurs in the shells usually about one quarter of the shell height from the ventral margin and extends up toward the hinge line parallel with the margin. Below the line, the interior surface is convex, and the line probably indicates the position of a simple pallial line. If this is so, the adductor muscles were set under and adjacent to the lowermost of the end hinge teeth.

Ligament.—The ligament area is wide and concave, the attachment being of the multichevron arcoid type. A primary rib making a sharp carina separates the ligament area from the ribbed area of the shell. There are about fifteen ligament grooves on each valve.

Hinge.—Hinge margin straight, extends nearly to anterior end. Anterior and posterior teeth similar, posterior slightly longer; teeth immediately under umbo vertical and very short. Three to four horizontal teeth at each end of hinge line, those nearest hinge margin longest. Between vertical central and highest horizontal, the teeth are oblique, angle to the hinge increasing towards the central vertical teeth. Oblique teeth between centre and horizontal teeth are at generally lower angle to the hinge margin posteriorly than anteriorly. All teeth have dendritic ridging and grooving across them, weakening at the bases of the sockets and the crests of the teeth which are smooth.

Affinities of robusta

The group of large shells to which Cox (1937) applied his new name *Indogrammatodon* have the essential features of shape and hinge structure of the genus *Grammatodon,* which distinguish these shells from members of *Parallelodon* and *Cucullaea,* but the shells differ from *Grammatodon* in size and ornamentation. According to Cox (1940, p. 46) species of *Grammatodon* do not attain the size of the type of *Indogrammatodon* and are more feebly ornamented, without the striking dissimilarity of ornament of right and left valves which characterizes the larger species constituting *Indogrammatodon.*

The diagnostic characters of *Indogrammatodon* given by Cox (1937, p. 195) are:—"Shell medium-sized to large (for the family), trapezoidal, rather elongate, inequilateral, with an obtuse and usually rounded-off posterior carina; umbonal region not very prominent. Cardinal area bearing numerous closely-spaced chevron-shaped ligament grooves. Ornamentation consisting of irregularly arranged, narrow radial ribs which do not correspond in the two valves, but are rather weaker and more diversified or more closely spaced in the right valve than in the left; in the right valve the ribs tend to be weak or altogether absent in the neighbourhood of the carina. Hinge consisting (as in *Grammatodon* s. str.) of a posterior series of three or four

elongate teeth parallel to the hinge margin and an anterior series of radially disposed teeth which are perpendicular to the margin, or nearly so, below the umbo, but become increasingly oblique towards the anterior end of the hinge line, until the end ones may be parallel to the hinge-margin."

The "family" referred to here is mentioned in the same manner in the "Subgeneric Characters" on p. 45 by Cox (1940). The family to which Cox referred *Indogrammatodon* in 1940 is Parallelodontidae.

The features of the Queensland species are very closely comparable with those enumerated in Cox's diagnosis given above.

The hinge structure and shape are the same and the ornament consists of irregularly arranged, sharp radial ribs which do not correspond in the two valves, being more diversified in the right valve. Two points of difference are to be noted here, however. In *robusta,* the ribs of the right valve are more diversified but are not weaker or more closely spaced, and the ribs are weak on the left valve as well as on the right in the neighbourhood of the carina.

The type of ornamentation of the right valve of the Queensland species is very similar to that shown in Cox's (1937, pl. 15; 1940, pl. 2) figures of the type species *I. virgatus,* with fairly fine, closely spaced primary ribs and intercalated fine second and perhaps third order ribs between the primaries. However, the ornamentation of the left valves shown in Cox's above mentioned plates consists apparently only of primary ribs much more strongly developed than the primaries of the right valves. The left valves of *robusta* have primary ribs of similar size and spacing to those of the right valves, and there are rather fine intercalated ribs between the primaries on the left valves. There is only very occasionally more than one finer rib between two primary ribs on the left valves of the Queensland specimens.

Although *robusta* conforms to the definition of *Indogrammatodon,* the tendency for difference in ornamentation between right and left valves is more subdued in the Queensland species than in the Jurassic species figured by Cox (1937, 1940).

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PALAEONTOLOGICAL PAPERS, No. 8

EOTRIASSIC MARINE BIVALVES FROM THE MARYBOROUGH BASIN, SOUTH-EAST QUEENSLAND

by

P. J. G. FLEMING

GEOLOGICAL SURVEY OF QUEENSLAND

ABSTRACT

Strata at Cordalba and Brooweena in the Maryborough Basin, south-east Queensland, have yielded the first Triassic marine macrofossils from eastern Australia. The areas involved are about forty miles apart and the strata were previously mapped as Brooweena Formation and thought to be of fresh water origin. The age of the fauna is shown to be Lower Triassic on the basis of comparison with faunas mainly in eastern Siberia, Japan and western North America where Lower Triassic bivalves occur in association with ammonoids. The following forms are described:— *"Ctenodonta" cordalbae* sp. nov., *Nuculopsis* (*Nuculopsis*) sp., *N.* (*Nuculanella*) sp., *Bakevellia capricorni* sp. nov., *Bakevellia* sp., *Myalina* sp., ? *Schizodus* sp. and *Neoschizodus teres* sp. nov. *"Ctenodonta" cordalbae* is very similar to an Ordovician species from Czecho-Slovakia, but a general consideration of relationships in the Palaeotaxodontida leads to the conclusion that it could be derived from an Upper Palaeozoic nuculid. *Bakevellia capricorni* (Pteriacea) is considered to suggest the possibility that Bakevelliidae were direct descendants of Leiopteriidae.

INTRODUCTION

Toward the end of 1963, Triassic marine macrofossils were discovered in the Maryborough Basin, south-east Queensland. This is only the second known occurrence of such fossils in the Australian continent, the first being that in the Perth Basin, Western Australia. Dickins and McTavish (1963) referred a fauna from a bore in the Perth Basin to the Otoceratan, the base of the Trias in the scheme of Spath (Spath, 1935, 1951; Kummel, 1954, 1959).

GENERALLY USED DIVISIONS OF THE LOWER TRIAS

Lower Trias	Scythian (=Eotrias)	Prohungaritan Columbitan Owenitan Flemingitan Gyronitan Otoceratan

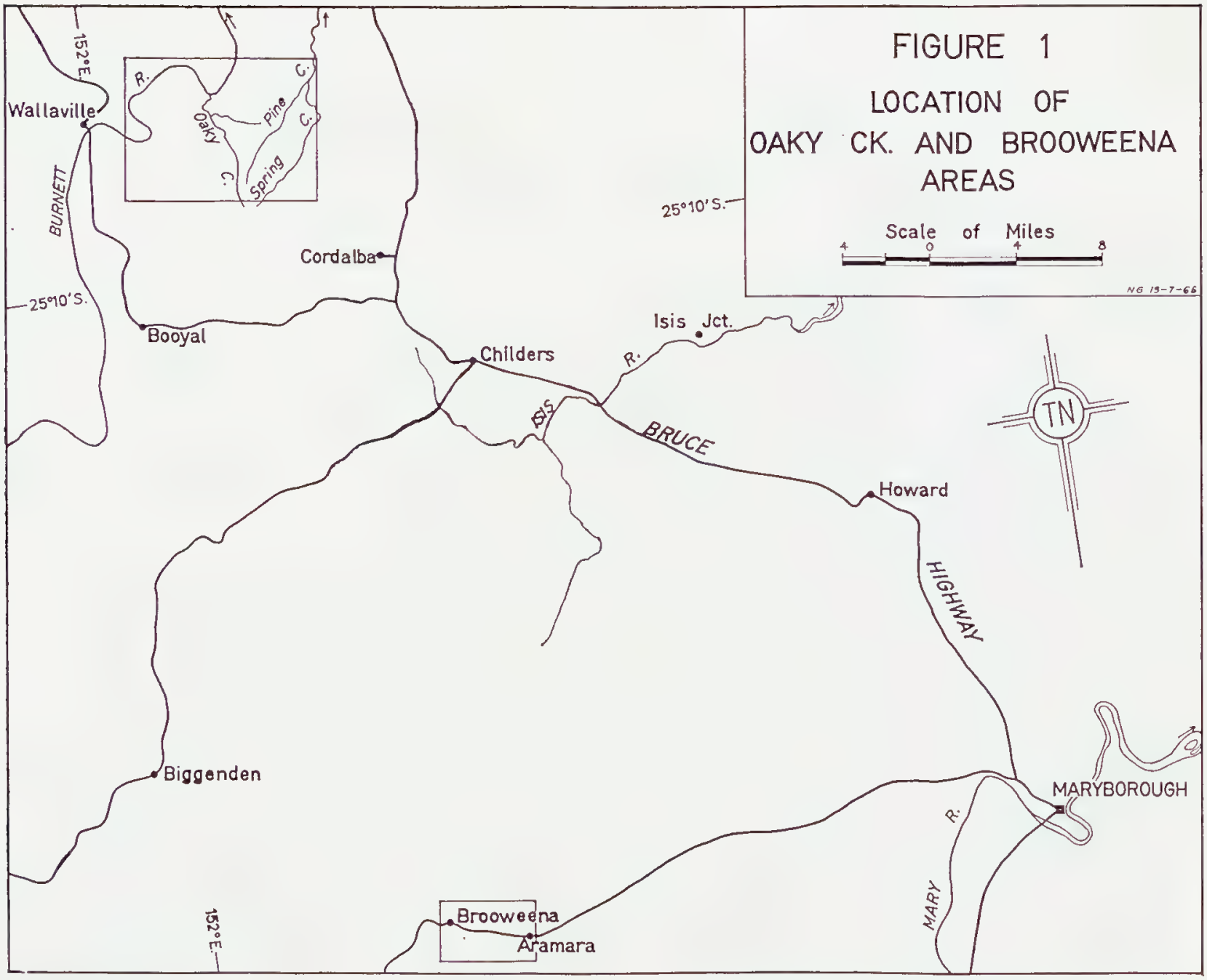
The Maryborough Basin (see Tectonic Map of Australia, 1960) is a "region of downwarp and sedimentation on a portion of the south coastal Lower Palaeozoic structural high" (Hill, 1960, p. 15). The eastern portion of the basin is covered by the sea and coastal sands and the western margin lies against unfossiliferous low grade metamorphics presumed to be of Lower Palaeozoic age, the South Coastal High (Hill, 1960, p. 13).

The oldest known fossiliferous rocks of the basin, the marine Lower Permian Gympie Group, lie against the western margin of the basin. Overlying rocks were grouped under the name Brooweena Formation by Bryan and Massey (1926) and correlated on indirect evidence with the Ipswich Coal Measures which have proved to be Middle or Upper Triassic (de Jersey, 1964). The Myrtle Creek Sandstone overlying the Brooweena Formation has not yielded fossils and is followed by the Tiaro Coal Measures considered to be of Jurassic age (Ridley, 1960, p. 297). The detailed relationships of these rock units are at present the subject of investigation by the Geological Survey of Queensland (G.S.Q.).

The fossils herein described have been collected from localities in strata mapped (Ridley, 1960, fig. 42) as Brooweena Formation, on the Brooweena–Aramara road and in an area about forty miles to the north in Cordalba State Forest near the Burnett River. The geographic position of these places is shown in fig. 1.

In Cordalba State Forest the fauna occurs near the base of a thick unit of dark grey siltstone and subgreywacke with isolated interbeds of quartz sandstone. This overlies a thick quartz sandstone whose relationship with the Permian is being mapped. Higher in the sequence than the marine Triassic beds a flora considered to be the same age as the Esk Beds (Hill, 1960, p. 271) has recently been collected (fig 2 and page 20).

The lithology of the fossiliferous unit in Cordalba State Forest is quite unlike that of the Brooweena Formation as described by Bryan and Massey (1926, p. 110). The lithologies mentioned by those authors may be seen in road cuttings between Brooweena and Aramara; except in the vicinity of Middle Creek Bridge, where the marine fossils occur in rocks very similar to those of Cordalba State Forest. Initially, geologists of Shell Development (Australia) Pty. Ltd. submitted collections from both areas for determination, and subsequently the collections were enlarged by geologists of the G.S.Q. The fossils were determined as marine Triassic (Scythian ?) by R. W. Day, formerly of the G.S.Q. (unpublished reports G.S.Q.), and a preliminary note on the occurrence was published by Denmead (1964).



Localities

Known localities for marine Eotriassic fossils in the Maryborough Basin are shown in figs. 2 and 3. Fig. 1 shows the positions of the areas represented by figs. 2 and 3 with respect to each other and to Maryborough.

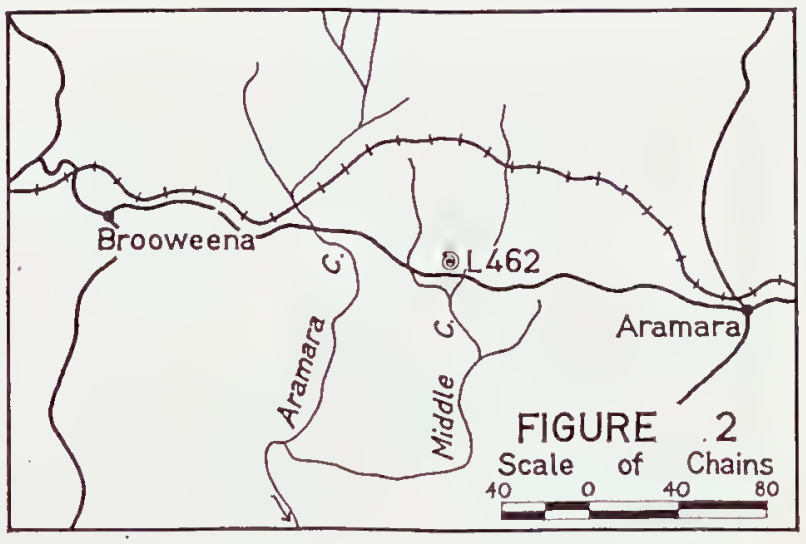
The locality on the Maryborough–Brooweena road between Brooweena and Aramara is in the north face of the second cutting west of Middle Creek bridge, grid reference 425164 on the Biggenden 1 : 63360 military sheet from which fig. 2 has been made.

The Queensland Forestry Department's 1 : 31680 map of Cordalba State Forestry Reserve 832 has been used as a basis for fig. 3. The area near the Burnett River from which marine Eotrias is known is heavily dissected by gullies, many of them crossing the strike of the beds. There seems to be little difficulty finding fossiliferous outcrops in the banks of the streams which flow into the western bank of Oaky Creek. However, the fossils occur in thin bands which must be searched for with care.

The locality from which the plant fossils mentioned on p. 20 were collected is shown as L 566 on fig. 3

All localities shown on figs. 2 and 3 are given as the L — numbers of the catalogued fossil collection of the G.S.Q.

All specimens mentioned are referred to by their F — numbers, their catalogue numbers in the collection of the G.S.Q.



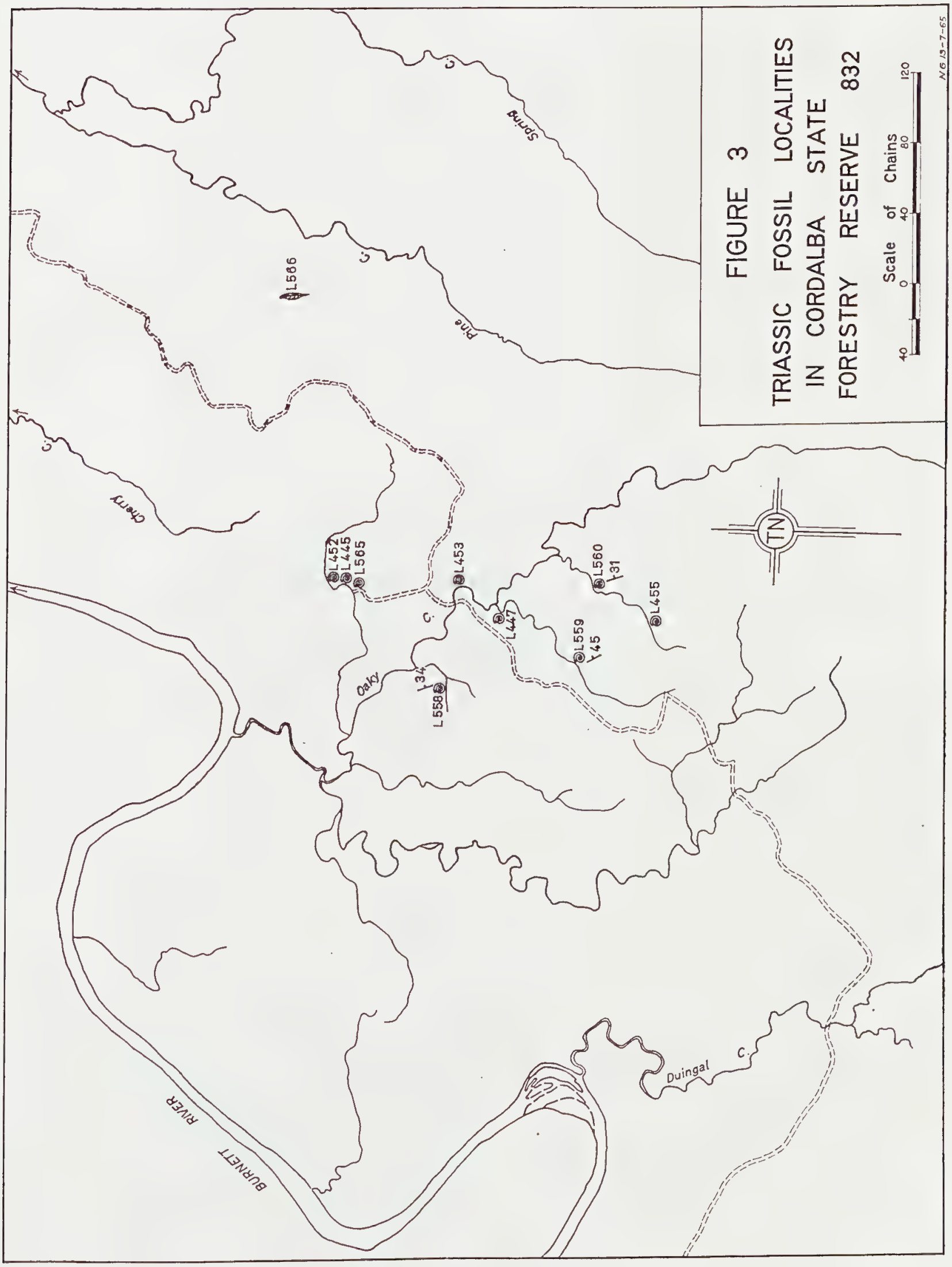


FIGURE 3
TRIASSIC FOSSIL LOCALITIES
IN CORDALBA STATE
FORESTRY RESERVE 832
Scale of Chains
40 0 40 80 120
NG 13-7-65
TN
L566
L452
L445
L565
L453
L447
L560
31
L455
L559
45
L558
34
Pine
Sprina
Cherry
Oaky
Duingal C.
BURNETT RIVER

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COMPOSITION AND AGE OF THE FAUNA

The following have been collected from Cordalba State Forest and are described:—

"Ctenodonta" cordalbae sp. nov.
Nuculopsis (*N.*) sp.
Nuculopsis (*Nuculanella*) *sp.*
Bakevellia capricorni sp. nov.
Bakevellia sp.
Myalina sp.
? *Schizodus* sp.
Neoschizolus teres sp. nov.

A small indeterminate shell with heterodont dentition may be related to *Eoastarte* Ciriacks, 1963, and a small, badly preserved ceratite probably belongs to the Permo-Triassic Otoceratáceae.

From the locality near Middle Creek Bridge on the Brooweena–Aramara road have been collected:—

"Ctenodonta" cordalbae
Bakevellia capricorni

and an unidentifiable coiled mollusc.

This fauna has little in common with known Australian Permian faunas and is, in fact, a quite novel generic assemblage.

Nuculopsis and *Nuculanella* occur in the Western Australian Permian (Dickins, 1963) and both occur in the Queensland Permian. *Bakevellia* has been known in Australia only from the Otoceratan of the Perth Basin. *Schizodus* occurs in the Queensland Carboniferous and Permian, but the true generic position of ? *Schizodus* sp. has not been determined. I know of no *Myalina* or *Neoschizodus* recorded from the Australian Permian.

The preliminary determinations published in the notice of discovery of marine Trias in Queensland (Denmead, 1964) are compared in the following table with the determinations now used.

Trigonucula	*"Ctenodonta" cordalbae*
Nuculopsis (*Nuculanella*)	*Nuculopsis* (*Nuculanella*)
Palaeoneilo	*Nuculopsis*
Parallelodon	? *Bakevellia*
Bakevellia	*Bakevellia*
Myalina	*Myalina*
Neoschizodus	*Neoschizodus*
Astartid aff. *Eoastarte*	Astartid aff. *Eoastarte*
? *Protophiceras*	indet. Otoceratáceae

For some of the forms, more adequate preparation and study of better material has necessitated changes in designations.

Considering that the determinable faunal elements are benthonic and so few in number, the age determination of middle or upper Eotriassic made here must be treated with appropriate reserve.

The generic assemblage does not give a clear indication of age, although the association of the typically Triassic *Neoschizodus* and variable *Bakevellia,* with the Upper Palaeozoic *Nuculopsis* and *Nuculanella,* is suggestive of an age near the Permo–Triassic boundary. This is consistent with the presence of a ceratitic ammonoid.

None of the individual genera is an adequate indicator. *Neoschizodus* has recently been recognized in the Upper Permian (Nakazawa, 1960) and *Bakevellia* occurs in the European Permian as well as through most of the Mesozoic. *Myalina* has an extended range and the stable nuculids are of little value in indicating age. No record of *Schizodus* from the Mesozoic is known to me, but the form called ? *Schizodus* sp. is too poorly known to be referred without doubt to *Schizodus.*

No specific identities are positively recognized. *Myalina* sp. may be conspecific with *M. putiatinensis,* but the specimens from Cordalba are not sufficient in number for positive identification. However, the Queensland *Myalina* indicates correlation with the Eotrias of eastern Siberia and the Middle Rockies. *Neoschizodus teres* is closely comparable with *Neoschizodus* cf. *laevigatus* of Nakazawa (1960) and may be conspecific. *Bakevellia capricorni* is a variable species of Triassic aspect and compares with Eotriassic species from eastern Siberia. I am unable to find in the literature any forms suggesting correlation with the remainder of the Cordalba fauna, even among the large number of nuculoids described from Triassic strata.

The association of *Bakevellia* and *Neochizodus* as dominant forms—in the absence of *Claraia*—is analogous to the similar occurrence from the coarse-grained facies of the Maizuru Zone reported by Nakazawa (1958). Nakazawa's *Neoschizodus–Bakevellia"* zone, which can be recognized throughout the entire Maizuru Zone, is placed in the middle Eotrias because of the presence of *Anakashmirites* ? sp. and *Pseudosageceras* sp. (Nakazawa, 1960, p. 269). Nakazawa refers to an older *Claraia* subzone of the *Neoschizodus–"Bakevellia"* zone. The apparent absence of *Claraia* at Cordalba seems significant and suggests that this fauna is younger than the *Claraia* faunas, for the genus is practically ubiquitous in bivalve assemblages of Otoceratan and Gyronitan age. It may range into the Flemingitan in the Ussuri Bay area. Hence, an Eotriassic age not lower than Flemingitan is suggested for the fauna described here. This is consistent with the occurrence of a flora of probable equivalence to that of the Esk Beds above the marine horizons; the flora contains the species *Dicroidium odontopteroides, Todites williamsoni* and *Asterotheca*

hillae. The Esk Beds are equivalent to or a little older than the basal (Kholo) stage of the Ipswich Coal Measures which are put in the Upper and possibly Middle Trias by de Jersey (1964, p. 19, table 3).

SYSTEMATIC DESCRIPTIONS

Subclass .. PROTOBRANCHIA Pelseneer

Order PALAEOTAXODONTIDA Korobkov

General considerations and possible relationships of "Ctenodonta" cordalbae *sp. nov.*

The Palaeotaxodontida (=Nuculacea) consisting of Ctenodontidae, Nuculidae, Nuculanidae and Malletiidae, is a well characterized group of protobranch bivalves whose early history is not yet clear and many of whose living representatives are poorly known.

Schenk (1934) "narrowly" defined the family Nuculidae in "a preliminary report". That is so far the only review of its kind for the nuculoids.

On the basis of work which shows *Nuculana* (=*Leda*) and *Malletia* to have the same soft anatomical organization, Nuculanidae and Malletiidae are merged by Yonge (1939). According to Yonge (p. 139) Malletiidae are Nuculanidae modified mainly in shell characters to fit them for life in soft abyssal mud. Without details of soft anatomy to refer to, palaeontologists will probably continue to find recognition of a family of externally ligamented, thin shelled non-rostrate genera, at present called Malletiidae, of practical value; (Nuculanidae are typically rostrate and, by definition, possess chondrophores). A compromise is to lower Malletiidae to subfamily status. Dall (1898, p. 597) followed this course, but it is not in accordance with the view of Cox (1959) who proposed derivation of Tertiary and living Malletiidae from the Ctenodontidae which, he says, were continued into the Cretaceous by "such species as *'Nucula' lineata* J. de C. Sowerby (H. Woods, 1899 (i), p. 7, pl. 1, figs. 28–32)". Cox suggested that the porcellanous shell of Malletiidae replaced a more primitive nacreous shell in early Ctenodontidae.

Ctenodontidae has been used to receive all pre-Tertiary Palaeotaxodontida without chondrophores. The breadth of interpretation of the genus *Ctenodonta* has probably accounted in large part for the breadth of interpretation of the family Ctenodontidae. In Salter's (1859) description of *Ctenodonta,* five species from the Ottawa River were named and figured. *C. nasuta* (=*Tellinomya nasuta* Hall, 1847) the type species, is an elongate, sub-rectangular shell. *C. contracta* Salter has become type species of *Tancrediopsis* Beushausen and is more like Nuculidae in shape (McAlester, 1963a, 1964). *C. gibberula* Salter, 1859, whose types are apparently lost (McAlester, 1963a) is somewhat nuculid in shape, but like *C. contracta,* it appears to have a slightly produced posterior end. The type species seems to be unlike most subsequently figured species of Ctenodontidae.

In the same way as species of many shapes have been included in *Ctenodonta,* the genera assigned to Ctenodontidae are of widely different aspect. Most of the genera are Palaeozoic, but *Palaeoneilo* extends into and through the Mesozoic. Palaeoneilo is similar in shape to some living Malletiidae and its Devonian type species, recently figured from the Snyder Creek Shale by McAlester (1963b), has poorly developed pallial sinuation. *Myoplusia* Neumayr is an elongate form whose type species is provided with a complex system of accessory musculature.

Nuculites and *Cleidophorus* are morphologically distinctive Lower Palaeozoic forms. *Praeleda* Pfab is a Lower Palaeozoic genus of peculiar shape, which seems to have no analogue in later horizons. The Devonian *Palaeoneilo constricta* (Conrad), type species of *Palaeoneilo* Hall, is conchologically very similar to living Malletiidae and Cox (1959) proposed derivation of Malletiidae from Ctenodontidae to which he referred *Palaeoneilo.* It is not conceivable that genera such as *Praeleda* and *Tancrediopsis* are in the same lineage as *Palaeoneilo.*

Consideration of the array of forms at present included in Ctenodontidae leads one to the conclusion to which McAlester (1964) has been led, that the family is heterogeneous, and the forms included in it are united by but one common feature, the lack of a chondrophore. This takes no account of shell shape and other features which must be important in Palaeotaxodontida as reflecting soft anatomical structure and relationships. There can be little doubt that the family grouping Ctenodontidae in its present broad sense is restrictive and that new groupings should be sought. McAlester (1964, p. 399) has declared his intention of proposing such groupings after restudy of some generic types.

The emphasis placed on ligament structure in the widely used family classification of Palaeotaxodontida (set down in Cox, 1959, p. 203) seems at variance with the observations of Bernard (1896, p. 80) who found that there is a tendency in *Nuculana* and *Yoldia* for the initially internal ligament to emerge; in *Malletia* this tendency results in the formation of a completely external ligament. This seems to indicate that the ligament is not as stable as must be assumed for unquestioned acceptance of the four families Nuculidae, Nuculanidae, Malletiidae and Ctenodontidae.

Although it seems there is no choice but to accept the fact that the earliest known Palaeotaxodontida were without chondrophores, it seems, in the light of Bernard's work, that it would be unwise to take the view that externally ligamented forms have never arisen from forms with chondrophores. It is not impossible that at least some externally ligamented forms arose from Nuculidae or Nuculanidae by emergence of the ligament. *Phaenodesmia* Bittner, *Nuculana*-like except for its external ligament, could be one such form. Some living Malletiidae could have arisen in Cainozoic times from Nuculanidae by emergence of the ligament and modification of shell shape, and others could be descendants of *Palaeoneilo*

whose continuation into the Cretaceous and close similarity to *Tindaria* (pointed out by Verril and Bush, 1898) are in accordance with its having been ancestral to at least some Malletiidae.

With regard to the new species described here, the possibility has been considered that "*C.*" *cordalbae* is a *Nuculopsis*. A great deal has been written about the position of the ligament in *Nuculopsis,* but even if Elias (1957) were correct in his assertion that the chondrophore lies below the tooth row without interrupting it (which is contrary to Schenk's 1934, pl. 2, fig. 19, drawing of a hypotype of the type species) one must be able to see the impression of the chondrophore beneath the hinge plate in well preserved internal moulds.

Campbell and Engel (1963) and Wilson (1960) figured hinges of forms assigned to *Nuculopsis* in which the chondrophore is simple in shape and set squarely between anterior and posterior series of teeth. These forms, therefore, do exist; are compatible with Schenk's (1934) abovementioned figure; and are of the type considered by Cox (1940, p. 12) to be more primitive in hinge structure than *Palaeonucula* Quenstedt whose chondrophore is similar to that of *Nucula.* The idea that this ligament type is primitive is in accordance with the hypothesis of evolution of genera with chondrophores from early Ctenodontidae; but Bernard's (1896) ontogenetic studies on *Nuculana, Yoldia* and *Malletia* allow of the possibility that it is in an emerging condition.

The striking similarity of "*Ctenodonta*" *cordalbae* to the Upper Palaeozoic Nuculidae and the possibility, based on Bernard's observations, that the ligament in at least some species of *Nuculopsis* is in an emerging state tempts one to interpret "*Ctenodonta*" *cordalbae* as a derivative of a *Nuculopsis* or *Nuculanella* rather than a surviving modified Triassic member of a Lower Palaeozoic externally ligamented genus.

However, for the present, it must be regarded as finding a place in a new family, in a genus based on a Czechoslovakian Ordovician species of which Dr. A. Lee McAlester has kindly sent me photographs. I am led to believe that the taxonomy of the Czech species will be published by Dr. McAlester.

"Ctenodonta" cordalbae sp. nov.

Pl. 7, figs. 1–3

Holotype: F 8569 from L 447

Paratypes: F 8565, F 8566a,b, F 8568 from L447

Description.—The shells are very small and thin, but are thickened in the hinge region. The shape is nuculiform, the opisthogyrate umbos whose points are about one-third of the shell length from the rear margin, projecting as much as 0·5 mm. above the hinge line in moulds. Anterior and posterior dorsal margins are slightly arched, but the umbonal slopes are slightly concave in lateral view of moulds, so that three or four teeth at each end of the hinge can be seen. The posterior and ventral margins make a smooth curve, the anterior end being slightly more sharply rounded. The margins are entire, smooth and wholly closed. It is thought that a lunule is not present, but a tiny escutcheon may be faintly impressed. External ornament consists only of irregularly spaced growth lines.

The pallial line is entire and weakly impressed and anterior and posterior adductor scars are the only visible musculature. A wide thickening bounds the postero-dorsal margin of the anterior adductor which is oval and parallel and close to the hinge. The erectly oval posterior adductor scar is evenly impressed near the rear extremity of the shell, not quite adjacent to the hinge. No ligament is visible nor is there any suggestion of a chondrophore in any specimen. The hinge teeth are nearly straight, but some are slightly chevron-shaped. They are in a continuous arched, not angular, series, There are eight to nine teeth behind the umbo and number five from the umbo is the largest and thickest. There are fifteen teeth in front of the umbo, number eight being the thickest. There is no sharp discontinuity in size or position of teeth below the umbo, but the middle teeth are very small.

Dimensions (mm.).—

	Length	Height	Breadth
Holotype	4·7	3·5	2·7
F 8565	4·4	3·5	2·5
F 8566a	4·8	3·7	2·7

Family NUCULIDAE d'Orbigny, 1844

Genus NUCULOPSIS Girty, 1911

Type Species.—Nucula ventricosa Hall, 1858, Pennsylvanian, Iowa, by original designation. *Nuculopsis girtyi* Schenk, 1934 is nom. nov. for *Nucula ventricosa* Hall which is a homonym of *Nucula ventricosa* Hinds, 1843.

Subgenus NUCOLOPSIS, s. str.

Nuculopsis (*Nuculopsis*) sp.

Pl. 7, fig. 4

Description.—The shape of the shells is not accurately known because of probable crushing. They are preserved as long, low shells with entire, smooth margins and sharply rounded anterior and posterior ends. The umbo is low, slightly turned towards the short end and moderately inrolled. No ornament is preserved and the shells are up to 7 mm. long with the point of the umbo 2 mm. from the rear.

Seven to eight almost horizontal teeth occur in the posterior row, continuous with about seventeen vertical teeth in the anterior row. The teeth are chevron-shaped. There is a sharp break in size of the teeth under the umbo where the larger posterior teeth meet the minute rearmost teeth of the anterior row. A fairly large chondrophore is present under the junction of the tooth rows.

The adductor muscle scars are very weakly impressed and not distinctly discernible, but are approximately under the ends of the hinge line.

Dimensions (mm.).—

	Length	Height	Breadth
F 8251 (L 445) ..	7·9	3·0	Not estimated

Remarks.—It is difficult to see diagnostic features in these small, poorly preserved shells. The presence of a chondrophore is not absolutely certain, but a fairly large depression in the hinge plate beneath the junction of anterior and posterior series of teeth is probably the impression of an internal ligament and is positioned in accordance with Elias's (1957) assertion concerning the hinge structure of *Nuculopsis*. The shape of the present species, though obscured by crushing, is not incompatible with that of *Nuculopsis*.

I am not aware of other records of *Nuculopsis* from the Trias and the specimens do not admit of useful comparison with Upper Palaeozoic species.

Subgenus NUCULANELLA Tasch, 1953

Type Species.—*Nuculanella piedmontia* Tasch, 1953, Pennsylvanian Dry Shale, Kansas, by original designation.

Remarks.—Dickins (1963, p. 30) regarded *Nuculanella* as a subgenus of *Nuculopsis*, considering that the difference between the two is in shape. The occurrence of transitional species such as *Nuculopsis sectoralis* (Winchell) and *N. houghtoni* (Stevens) figured by Driscoll (1964, pl. 16) appears to justify not giving *Nuculanella* generic status. Dickins alluded to such species in his discussion of the genus *Nuculopsis*.

Nuculopsis (*Nuculanella*) sp.

Pl. 7, fig. 5

Description.—The shells are very small and opisthocline. The umbo is one-quarter to one-third of the shell length from the back, nearly erect and pointed postero-dorsally. The valve margins are non-denticulate, completely closed, and the commissure is an oval with its long axis pointing in the same direction as the umbos; the short axis is only about two-thirds as long as the long axis.

Only the tip of the umbo projects above the cardinal margin so that a side view of the internal mould shows most of the hinge teeth. No ornament is preserved.

The pallial line is entire. The adductor scars are set under the ends of the hinge line. They are erectly oval and marked off from the umbonal slopes by prominent rounded thickenings. They are not impressed ventrally. There are no other scars preserved in the shells.

Anterior and posterior series of teeth, both slightly arched, make an angle of about 100° under the umbo. The tooth rows seem to be separated by a narrow vertical chondrophore although minute teeth may pass over the chondrophore. Preservation is inadequate to determine the hinge structure in more detail. The teeth of both rows are chevron-shaped and of similar size. There are about six teeth in the posterior row and fourteen in the anterior.

Dimensions (mm.).—

	Length	Height	Breadth
F 8250 (L 445) ..	3·8	4·0	Not estimated

Remarks.—The species is comparable in shape with *N. bangarraensis* Dickins (1963, pl. 1, figs. 7–12) from the Permian of Western Australia and appears to be congeneric with the type species of *Nuculanella* figured by Tasch (1953) and Dickins (1963).

The hinge structure of *Nuculanella* sp., though not thoroughly known, is consistent with the generic position chosen for the species. No other record of *Nuculanella* from the Trias is known to me.

Subclass PTERIOMORPHIA Beurlen
Order PTEROCONCHIDA Cox
Superfamily PTERIACEA Dall, 1895
Family BAKEVELLIIDAE King, 1850

Remarks.—The family name was resurrected by Cox (1955) to include *Pteria*-shaped genera of pterioids with multiple ligament pits on the area. Isognomonidae has often been used to receive such genera.

Genus BAKEVELLIA King, 1848

Type Species.—*Avicula antiqua* Münster, Permian, Europe.

Diagnosis.—See Cox (1940, p. 108).

Bakevellia capricorni sp. nov.

Pl. 7, figs. 7–12; pl. 8, figs. 1–7

Holotype.—F 8255 from L 558.

Paratypes.—F 8240, F 8253, F 8272, F 8273, F 8879 from L 558; F 8266, F 8267 from L 560.

Diagnosis.—*Bakevellia* with short anterior buttress under the hinge; buttress supporting the more anterior of the very small pseudotaxodont cardinal teeth. In some specimens a tubercle-like tooth surmounts the buttress and cardinals are present behind it. In other specimens the tubercle and cardinals are replaced by thickening. The buttress apparently separates the anterior adductor attachment from the body of the shell. Anterior ear not defined. No byssal sinus or gape. Pallial line a row of pits extending from the posterior adductor scar to the larger and more anterior and ventral of the two muscle scars behind the buttress in the umbonal cavity.

Description.—The shells are thin and inequivalve. The left valve is more inflated than the right and its umbo projects slightly above the hinge line, that of the right valve being depressed and usually indistinct. The beak is about one third of the hinge length from the anterior end. The valves are longer than high. The cardinal margin is usually more than half as long as the shell. The anterior ear is reduced and inflated and not marked off by a sulcus. The posterior ear is flat near the cardinal margin, but there is no distinct break in slope anterior to the ear, nor is there a sinus in the posterior margin. Right valves are only a little tumid, left valves moderately so. Some specimens have a broad, low carina from the umbo to the postero-ventral region, but this may be only the result of

distortion. The margins are entire, cardinal straight, anterior sharply rounded, postero-ventral broadly rounded and the upper part of the posterior almost straight. The shells are smooth or have weakly developed growth lines. The pallial line has no sinus, is weakly impressed ventrally in most specimens, consists of a row of pits and is not parallel to the margin, but straight or upcurved below the umbo, and curves posteriorly before returning forward to meet the posterior adductor. The posterior adductor scar is weakly impressed and is not visible in most specimens. It is situated below the posterior end of the cardinal margin and just above the maximum inflation of the shell. The pallial line ends anteriorly in a small pit in the anterior side of the umbonal cavity. Another, deeper pit is present higher in the same part of the umbonal cavity. These pits are thought to be pedal muscle and visceral supporting muscle scars, by analogy with living *Pinctada*. An anterior adductor impression has not been seen.

A hinge plate is not developed. The dentition, when fully developed, consists of laterals and cardinals. Many specimens are practically edentulous and many more have only laterals, the cardinals being reduced to subumbonal shell thickening. Seldom are two shells found to have the same dentition.

The hinge structures present in material referred to the species are as follows:

An anterior buttress not extending much below the cardinal margin supports either a single or a bifid tubercle-like tooth. Behind the tooth there are two or more weak, short, vertical lamellar teeth. Two more of these may take the place of tubercle. The laterals are elongate, anteriorly parallel to the cardinal margin and posteriorly diverging from it and thickening. Commonly there is one in each valve, that of the left fitting over that of the right. An elongate groove-like socket is usually present above the tooth of the right valve and below the tooth of the left. There is often no trace of cardinal teeth, though the buttress is always present. Most specimens have a lateral tooth.

The ligament area is fairly wide, smooth, or longitudinally striate and with rectangular ligament pits traversing it. The ligament pits are higher than they are long. There are usually two or three pits, but one or four occur on some specimens. The pits are not uniform in size or spacing.

Dimensions (mm).—

	Length	Height	Breadth (Single valve)
F 8255 holotype ..	28	15	5
F 8273	>26	20	5
F 8266	23	19	6

Remarks.—The species most closely comparable with *Bakevellia capricorni* appear to be those of the widespread Scythian group of which *Gervillia mytiloides* Schlotheim, *G. exporrecta* Lepsius et var. and *G. ussurica,* figured by Kiparisova (1938), are members. *G. exporrecta* var. *linearis* Ogilvie-Gordon (Kiparisova, 1938, pl. 6, figs. 1, 2, 3a and b) is most closely comparable with specimens from the Maryborough Basin. Some of the more erect left valves of *B. capricorni* are similar to Kiparisova's fig. 22, pl. 5 of *G. exporrecta.*

Cox (1932, pl. 7, fig. 13) figured a shell under the designation *Gervillia* cf. *exporrecta* Leps. It is similar to some specimens of *B. capricorni* in shape, but Cox reconstructed the posterior ear with a point. The specimens of *B. capricorni* have rounded postero-dorsal margins as shown in Kiparisova's abovementioned figures.

Spath's figures (1935, pl. 10, figs. 11a and b; pl. 12, fig. 4) of the form called *Gervilleia* aff. *exporrecta* show a longer hinge than my specimens, but the form is practically identical in shape with *Bakevellia* sp. of Dickins and McTavish (1963, pl. 2, figs. 7 and 8).

Newell and Kummel (1942) and Ciriacks (1963, p. 76, pl. 16, fig. 10) mention respectively *Gervillia ussurica* (Kiparisova, 1938, pl. 6, figs. 5–8), and *G.* cf. *ussurica* from the Dinwoody Formation of the Middle Rockies. The identifications are based partly on the association of the forms with the *Claraia* fauna.

All the abovementioned species are closely interrelated. They bear some resemblances to other Triassic forms such as those figured by Mansuy (1919, pl. 1, figs. 18–20) and Healey (1908, pl. 2, pl. 3). Mansuy's specimens are referred to *Heornesia* Laube and have strongly inrolled umbos, but otherwise are similar in shape to the abovementioned Scythian group. Healey's figures of the hinges of *Gervillia shaniorum* show some similarity to the hinge (when fully developed) of *B. capricorni*. She declares (p. 17) that the hinge type is Triassic.

The shells figured by Krumbeck (1924) from Timor are not closely comparable with Maryborough Basin forms.

The possible bearing of Bakevellia capricorni *on pterioid phylogeny*

The holotype of *Bakevellia capricorni* sp. nov. is considered to belong to *Bakevellia* s.s. as defined by Cox (1940, p. 108). Although there is great variation among the shells referred to *B. capricorni,* preliminary biometric observations do not seem to indicate that more than one species is present. Their occurrence in the field appears to substantiate this, for all variants occur together at all localities and, although some of the shells, particularly edentulous ones, would not themselves be referrable to *Bakevellia* s.s., there are intergradations between them and forms with the characters of that genus. The characters of the musculature, described below, are common to all the specimens. According to Cox (1940, pp. 106–107) there may be considerable variation in dentition within a species of *Bakevellia* in the Trias. Credner (1851, pl. 6) figured seven species showing some of the hinge variations of Triassic *Bakevellia*. The closest of these Thüringian species to the holotype of *B. capricorni* is *Gervillia socialis.*

The leiopteriid *Dozierella* Newell, from the Upper Permian of the United States, is very similar in shape to *B. capricorni,* has elongate posterior laterals and, under the cardinal teeth, a buttress separating the anterior adductor scar from the body of the shell. Another leiopteriid, *Merismopteria* Etheridge fil., redescribed by Dickins (1960), is similar in shape to *B. capricorni* and has dentition similar to species of living Pteriidae.

Merismopteria and *Bakevellia capricorni* both possess a pallial line consisting of a row of pits ending anteriorly in one or two deeper pits, presumably the scars of pedal muscles or muscles supporting the viscera, probably not, because of their position, adductors, as thought by Nakazawa (1954). The anterior adductor scar is in front of the buttress in *Merismopteria* (see Dickins, 1960, p. 388, text-fig. 1). In *B. capricorni,* the anterior adductor impression cannot be distinguished, but it is presumably either obsolete or very small and located very high and near the anterior margin in front of the short buttress. Dickins (*op. cit.,* p. 389) concludes that the musculature of *Merismopteria* is more primitive than that of adult living pteriids in having more highly developed anterior adductor and pedal muscles. The pedal muscles of *B. capricorni* are not as large as in *Merismopteria* and are higher in the umbonal cavity, thus approaching the condition in the living *Pinctada.* Further, obsolescence of the anterior adductor has apparently progressed further in *B. capricorni* than in *Merismopteria* (cf. *Bakevellia* sp. of Dickins and McTavish, 1963, p. 129).

It seems that a very close relationship between *Merismopteria* and *B. capricorni* is indicated by hinge structure, musculature and shape. This morphological relationship is so close that it arouses the suspicion that *B. capricorni* may be derived from the Queensland Permian genus.

In figure 10, Dickins (1963, p. 71) shows the family Bakevelliidae which, he comments, might be better regarded as a subfamily of Isognomonidae. It is not clear from the diagram what his thoughts on the derivation of the family are, but he shows it as having risen directly from Leiopteriidae, although a dotted line presumably indicates either that Bakevelliidae is polyphyletic or that it may have come entirely from early Pteriidae. In this connexion it may be noted that Cox (1940, p. 105) thought that the various genera of Isognomonidae (including Bakevelliidae) may have arisen independently from different genera of Pteriidae (including Leiopteriidae). However, direct derivation of bakevelliids from Leiopteriidae is contrary to the widely accepted belief that forms with serial multivincular ligaments arose from those, like *Pteria,* with a single resilifer (Dall, 1900, p. 358; Newell, 1937). This belief is well supported by the ontogenetic studies of Jackson (1890) who declares that *Perna* is unquestionably a branch from *Avicula* and says that *Bakevellia* appears to be a branch from *Avicula* in the some "line of variation" as *Perna.*

The species *Phelopteria dalli* described by Stephenson (1952, p. 68, pl. 14) has shells made up by several distinct pairs of valves. Each pair after the outside one is enclosed between the partly open valves of the preceding pair, the several pairs being separated from each other by thin films of matrix. Stephenson (p. 69) interprets the small, inner, multivincular shells as juvenile and the outer, alivincular shells as adult. Although this may indicate that the alivincular ligament can be derived from the multivincular in phylogeny, it is possible that it confirms the opposite view, that of Jackson (*op. cit.*), for although Stephenson interprets the smaller shells as being juveniles, from his hypothesis of formation of the composite shells one must conclude that the smaller shells are formed later in the animal's life than the larger.

Dickins (1960, p. 390) remarks that *Bakevellia,* having multiple ligament pits on the area, is apparently derived from a form with a single ligament pit. However, he knows of no definite occurrence of a pteriid (with a single resilifer) in the Palaeozoic. The type species of *Bakevellia* is from the Upper Permian of Europe and a pterioid called *Bakevellia* (in Shimer and Shrock, 1944) occurs in the Pennsylvanian of the United States. In the hypothesis of derivation of Bakevelliidae from pteriidae, a difficulty arises with the existence of Bakevelliidae for so long before the period in which members of the supposed ancestral family are found. The Leiopteriidae, however, were in existence in the Lower Palaeozoic (see Cox, 1960, p. 75) and no temporal difficulty in the derivation of Bakevelliidae from them exists. Neville George (1933) has warned against too ready acceptance of ontogenetic evidence in cases where the geological record is contradictory to the supposed phylogeny.

In summary, it is concluded here that:

(1) The idea that Bakevelliidae descended from pteriidae with one resilifer is based, to a perhaps unwarranted degree, on Jackson's (1890) ontogenetic study of *Perna ephippum* which passes through three stages roughly corresponding in morphology with *Pteria, Bakevellia* and *Isognomon* (= *Perna*).

(2) There is a temporal difficulty in deriving the first known serially ligamented forms, *Bakevellia,* a partly Upper Palaeozoic genus, from Pteriidae, a post-Palaeozoic family.

(3) *Bakevellia capricorni* is so similar in shape, musculature and dentition to *Merismopteria* (? = *Leiopteria*) that a very close relationship is suggested.

(4) From the chronological relationship of *B. capricorni* and the Permian *Merismopteria,* and a consideration of the musculature of them and the living *Pinctada,* it seems possible that *B. capricorni* is a descendant of *Merismopteria* or a closely related Pterioid.

Bakevellia sp.

Pl. 8, fig. 8

Dimensions (mm).—

	Length	Height	Breadth (single valve)
F 9494 (L 445) ..	>17	>9	>2

Remarks.—*Bakevellia* sp. comprises a discrete group, distinguishable, with available material, from *Bakevellia capricorni* by characters of the hinge. *Bakevellia* sp. is characterized by small size and the development of transverse teeth behind the umbo and in front of short posterior laterals. Such hinge teeth are known in the Trias (Cox, 1940, pp. 106–108; Credner, 1851, pl. 6, fig. group 6; Nakazawa, 1954, pl. 5 figs. 3–4). In fact, the present form is not unlike *Gervillia polyodonta* figured by Credner (loc. cit.) except that *polyodonta* has one or two more sub-horizontal laterals and more ligament pits.

Although *Bakevellia* sp. is characterized by constant small size, it is not absolutely distinguishable from *B. capricorni* by this feature. Some specimens with the hinge characters of *B. capricorni* are as small as *Bakevellia* sp.

In musculature, *Bakevellia* sp. is identical with *B. capricorni*. The pallial line pits, pedal muscle scars and anterior buttress are present and identically disposed, and no scar of an anterior adductor can be seen.

The possibility has been considered that these shells are young specimens of *B. capricorni* and that the posterior transverse teeth are absorbed during growth. However, some shells smaller than *Bakevellia* sp. and without transverse posterior teeth are to hand and appear more likely to be young *B. capricorni*.

Order	ISOFILIBRANCHIDA Iredale
(= Superfamily	MYTILACEA)
Family	MYALINIDAE Frech
Genus	MYALINA de Koninck, 1842

Type Species.—*Myalina goldfussiana* de Kon., 1842, Carboniferous, Belgium, by subsequent designation of Stoliczka, 1871.

Myalina sp.

Pl. 7, fig. 6

Description.—Shell equivalve, non-alate and about twice as high as long. It is not known whether the margins are entire and distortion makes some other details of shape obscure. Anterior margin slightly concave and posterior gently convex. Umbo pointed and sub-umbonal anterior region rolled over upper part of anterior margin. Only ornament is of growth lines. Musculature and pallial line not preserved. Hinge edentulous. Ligament area amphidetic, narrow, bearing five parallel grooves. Dorsal margin varies in position from horizontal to steeply inclined.

Dimensions (mm.).—

	Length	Height	Breadth (single valve)
F 6482a (L 455) ..	14	30	3

Remarks.—*Myalina* sp. is most closely related to the Lower Triassic group of species mentioned by Newell and Kummel (1942, p. 956), which occur in Eastern Siberia, the Middle Rockies (U.S.A.) and East Greenland (Spath, 1935, pl. 20, fig. 12; pl. 21, fig. 15). Two of this group, *M. putiatinensis* Kiparisova (1938, p. 261, pl. 6, figs. 10–12) and *M. spathi* Newell and Kummel (loc. cit., p. 3, fig. 11) are very closely allied to the present *Myalina* sp. Newell and Kummel record *M. putiatinensis* in association with *M. spathi* in the Dinwoody Formation, and Ciriacks (1963, pl. 16, figs. 1–6) also recognizes both species in that formation.

One or both of the above species may be represented by the specimens here designated *Myalina* sp. The specimen figured here is erect, but oblique forms are included in *Myalina* sp. The two are grouped here since both shapes are represented in Kiparisova's figures of *M. putiatinensis*. However, Kiparisova (op. cit., p. 292) states that *M. putiatinensis* is variable in shape, but Newell and Kummel (op. cit., p. 957) refer to it as "this distinctive oblique *Myalina*", placing the more erect, robust specimens in *M. spathi*. The small number of specimens before me does not allow of a specific identification, but the material seems to indicate correlation of the Cordalba, Dinwoody and Putiatin Is. faunas.

Subclass	HETEROCONCHIDA Hertwig
Order	SCHIZODONTIDA Steinmann
(= Superfamily	TRIGONIACEA)
Family	MYOPHORIIDAE Cox, 1951
Genus	SCHIZODUS King, 1844

Type Species.—*Axinus obscurus* J. Sowerby by subsequent designation of de Verneuil, 1845; Upper Permian Magnesian Limestone, Garforth, Leeds, England.

Remarks.—The authorship of *Schizodus* and the identity of its type species have recently been discussed by Maxwell (1964, p. 9). Dickins (1963, p. 100) accepted that de Verneuil and Murchison (1844) were the authors of *Schizodus,* but Maxwell (p. 10) pointed out de Verneuil and Murchison's reference to King's responsibility for proposal and indication of the genus.

?*Schizodus* sp.

Pl. 8, fig. 9

Description.—Small shells, elongately oval, probably moderately inflated and with a trace of a flanking plication. Umbo slightly prosogyrous, low and not inrolled. Anterior adductor scar high, near antero-dorsal margin. Posterior scar not preserved. Pallial line entire. No hinge plate; cardinal region slightly thickened. Two cardinal teeth (4a and 2b) and possibly a weak pseudo-lateral (4b) in the left valve. 4a is more prominent than 2b and is elongated in the antero-dorsal to postero-ventral direction. 2b is a thick, low, vertically elongated tubercle. The slight

elevation bordering the cardinal margin may be 4b. Right valve has sub-umbonal pit for reception of 2b, bordered by very weak ridge in front (3a) and triangular, blunt tubercle behind (3b). Posterior corner of 3b is produced into a short, low ridge. A very shallow pit for the reception of 4b is thought to be present.

Dimensions (mm.).—

	Length	Height	Breadth (single valve)
F 8248 (L 445)	7·3	3·8	1

Remarks.—This is so poorly represented in the fauna and so poorly preserved that much doubt remains as to its generic position. The relative sizes of the hinge teeth are not as in *Schizodus obscurus* (described by Cox, 1951), but this may not exclude the present form from the genus *Schizodus*. It seems not to be the young of *Neoschizodus teres* sp. nov. in view of its elongately oval shape and apparent lack of a buttress. The smallest specimens of undoubted *N. teres* available are no bigger than the shells in question and already are circular or subtrigonal with quite strong buttresses. Undoubted *Schizodus* is not known above the Permo-Triassic boundary.

Genus NEOSCHIZODUS Giebel, 1856

Type Species.—*Trigonia laevigata* Zieten, 1830, Lower Trias, Europe.

Remarks.—*Neoschizodus* was resurrected by Cox (1951, p. 369) for the reception of smooth species having both a fully developed myophoriid hinge and a myophorous anterior buttress as in *Myophoria* Bronn. The genus had been neglected by most authors up to that time, the type and other species usually being included in *Myophoria*. Nakazawa (1960) gives a useful summary of genera of Myophoriidae.

Neoschizodus teres sp. nov.

Pl. 8, figs. 10–11; Pl. 9, figs. 1–7

Holotype.—F 8230 from L 559.

Paratypes.—F 9063, from L 460; F 8229, L 559; F 8227–8, L 565.

Diagnosis.—*Neoschizodus* with strongly and fully developed myophoriid hinge teeth, and strong, thick myophorous buttress. Marginal outline circular to slightly trigonal. Smooth, or with ornament of growth rings. Flank bearing very wide, low, poorly defined fold.

Description.—Slightly prosocline specimens with slightly trigonal to almost circular marginal outline and of moderate inflation are considered to be least distorted. Such a specimen is shown in Pl. 9, fig. 1. The shell is equivalve and only slightly inequilateral. The margins are entire and the umbos not at all inrolled, their points being at the same level as the cardinal margins. Maximum inflation is very little greater than umbonal inflation and is at one third of the height below the cardinal margin. The shell is moderately thick.

There is no external ornament, but the surface of the shell bears concentric growth marks of varying coarseness. In some specimens the surface is distinctly undulose. No lunule or escutcheon is visible. There is a very low, wide plica extending from the beak postero-ventrally, but becoming wider and indistinct toward the margin. The postero-dorsal slope is very gently concave. The remainder of the shell is evenly inflated.

The pallial line is entire, and strongly impressed at one quarter to one third of the shell height from the ventral margin. The anterior adductor scar is narrow, lying in the small space between the anterior margin and the buttress ridge. It is very weakly impressed. The posterior adductor scar has not been seen clearly in any specimen. In well preserved specimens of both valves, pedal muscle scars are present as deep, narrow pits in the apex of the umbonal cavities. The buttress ridge extends antero-ventrally for from one sixth to almost one third of the total height of the shell. In the right valve it supports the sub-umbonal tooth and in the left it supports the anterior tooth and the chondrophore-like socket behind. The buttress is very thick.

4a is narrowly triangular, strong and short, and extends forward. 4b is narrow, elongate, and parallel to the margin. The upper part of 2b is strong, projecting and sub-triangular. Its posterior side is produced below 4b and extends as far as the rear end of 4b. 4a and 2b are joined by a chondrophore-like structure for the reception of 3a. 3a is strong, projecting and squarely placed on the buttress. 3b is fairly strong and parallel to the margin. 3a and 3b are not visibly separated above the pit which receives 2b.

A ligament groove lies along the cardinal margin behind the umbo.

Dimensions (mm.).—

	Length	Height	Breadth (single valve)
F 8230	19	17	6
F 8229	20	15	4
F 8227	16	20	5·5

Remarks.—Members of a group of closely related shells have been figured from widely scattered Triassic localities in the Northern Hemisphere and either identified or compared with the type species of *Neoschizodus*. Cox (1932) summarized the then known geographic and stratigraphic distribution of the type species under the generic designation *Myophoria*. He found it was widespread in Europe and Asia and had been found in Scythian and Middle Triassic strata. It has since been found in North America and was figured by Ciriacks (1963, pl. 16, figs. 18 and 19) from the Scythian Dinwoody Formation of the Middle Rockies.

Both Ciriacks' (loc. cit.) and Cox's (1932, pl. 7, fig. 5) figures of *M. laevigata* are of carinate forms with myophorous buttresses less well developed than in *N. teres*. Both are sub-quadrate with angular postero-ventral extremities and markedly anterior umbones. Although they are more depressed dorso-ventrally,

they have the characters of shape and carination of *Trigonia laevigata* as represented by Zieten (1830, pl. 71, figs. 2 and 2b).

Neoschizodus teres differs from the shells figured by the above authors in being almost circular in marginal outline and in having a wide, low fold rather than a carina on the flank. From the shells figured by Cox and Ciriacks it differs also in having a much more heavily thickened anterior buttress. *Myophoria praeorbicularis* of Cox (op. cit., pl. 7, fig. 4) is similar in shape, but has much less strongly developed hinge structure.

The form most similar to *N. teres* is *N.* cf. *laevigatus* of Nakazawa (1960, p. 56, pl. 6, figs. 21–32) from the Scythian of the Maizuru Zone, S.W. Japan. From the figures given by Nakazawa, only minor differences between *N. teres* and the Japanese form can be seen. *N. teres* seems to have a very slightly thicker buttress, more deeply impressed pallial line and shallower muscle scars. Obviously, Nakazawa's *N.* cf. *laevigatus* and *N. teres* are more closely related to each other than to *Trigonia laevigata* Zieten, and may be conspecific.

N. cf. *laevigatus* is common in the Scythian of the Maizuru Zone. The significance of the occurrence of *N. teres* with *Bakevellia capricorni* in the absence of *Claraiae* is discussed under the heading "Composition and Age of the Fauna" (p. 20).

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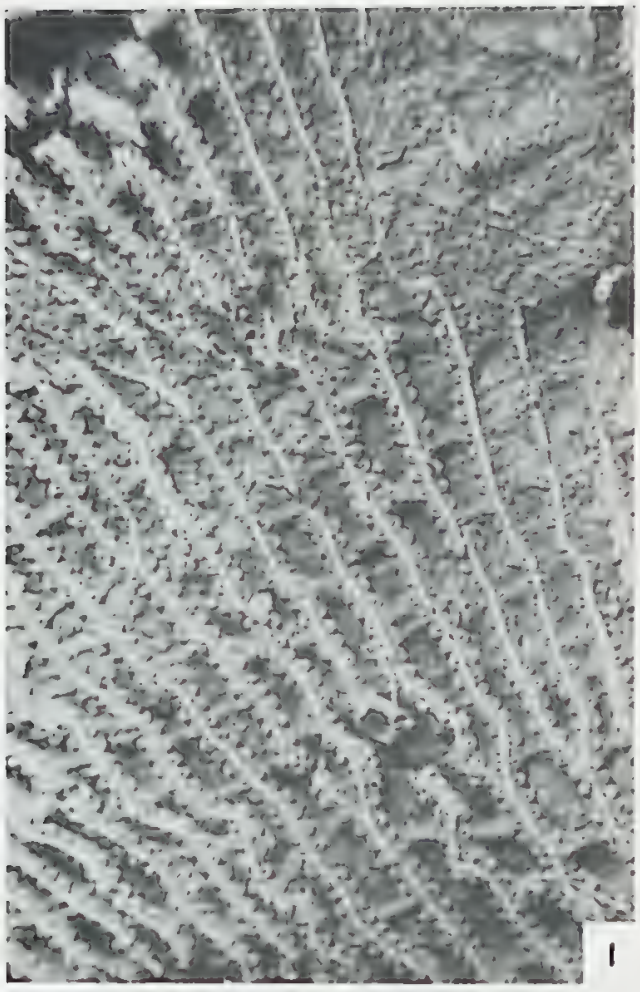
EXPLANATION OF PLATE 1

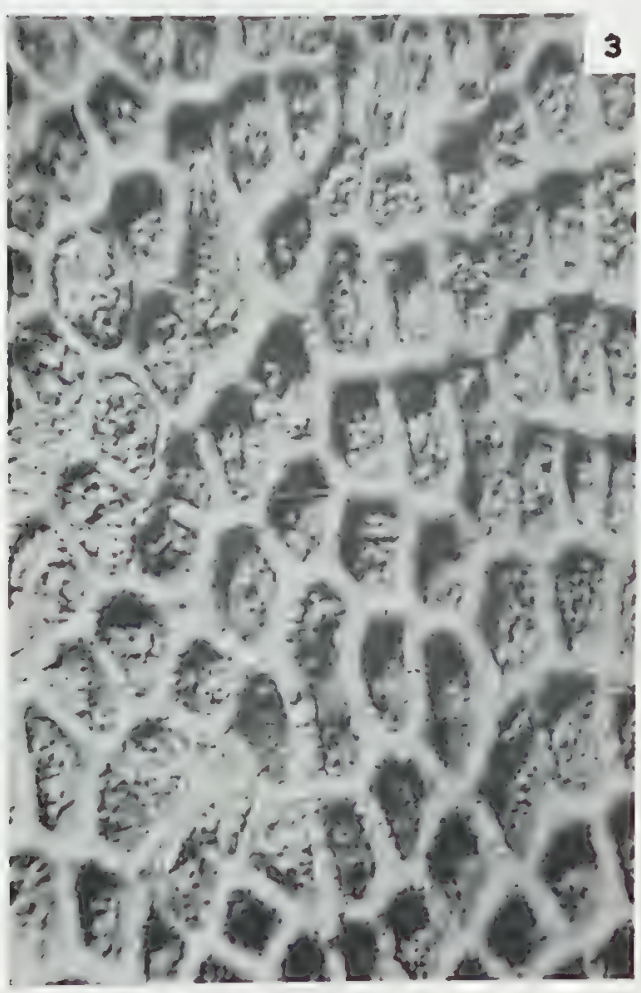
Figs. 1–4. *Fenestella* (*Bajoola*) *capellae* subgen. et sp. nov.

1. F 9821, holotype. Latex cast of obverse showing characters of mesh. x 9.

2,4. F 9821, holotype. Latex casts of parts of surface showing detail. Approximate position of some zoecial bases inked in at lower left of fig. 4 to show how proximal tips lie inside distal ends of preceding pair. 2 x 18, 4 x 25.

3. F 10202, paratype. Slightly weathered reverse of specimen showing typical appearance. x 8.





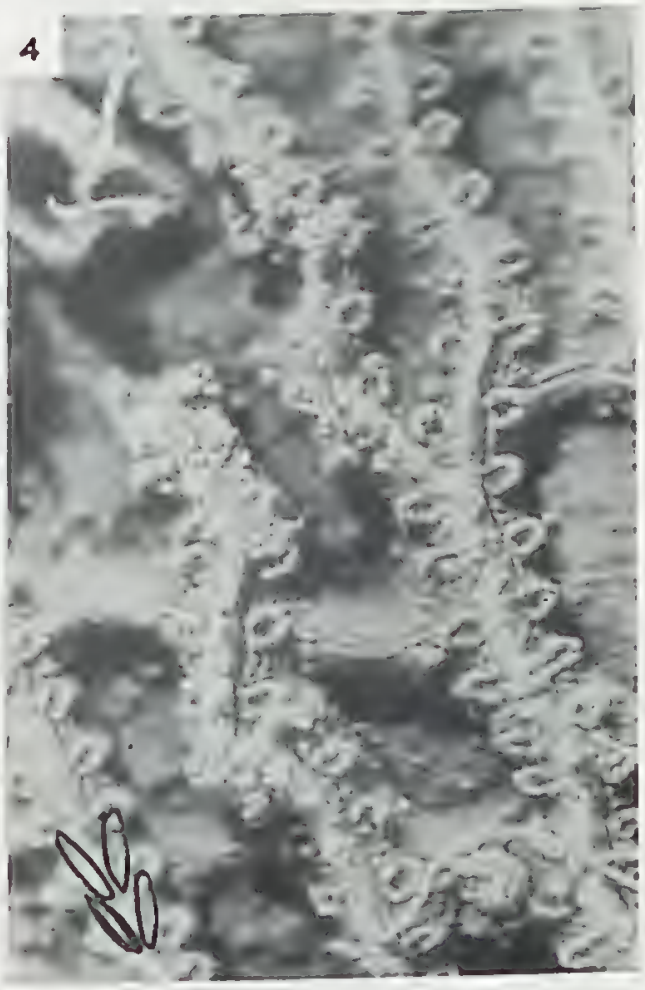


PLATE 1

EXPLANATION OF PLATE 2

Prefix QM refers to Queensland Museum specimens; GSQ to Geological Survey of Queensland specimens.

Figs. 1–5. *Leionucula quadrata* (Etheridge) 1872.

1. QMF 17/1244. a, holotype of *Nucula gigantea* Eth. b, associated specimen on same piece of rock. x 2.

2. QMF 17/1245. Lectotype of *Nucula quadrata*. a, left, little distorted valve not figured by the author of the species. x 2. b, right valve figured by Etheridge in 1872, considerably crushed. x 2.

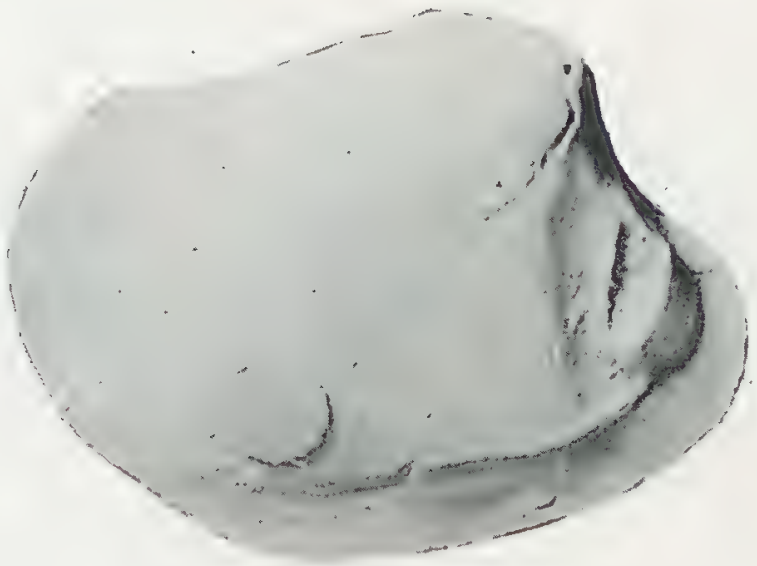
3. QMF 17/1246. Syntype of *Nucula quadrata*. This specimen thought to be the subject of Etheridge's (1872) pl. 19, fig. 5. The right valve of this specimen is very badly distorted. x 2.

4. GSQF 6829. Small topotype not much thickened and slightly crushed laterally, showing an intermediate state between the "*gigantea*" form and that of typical *quadrata*. x 2.

5. GSQF 6871. Topotype with very thin shell and slight muscle impressions, crushed laterally and taking on the appearance of "*gigantea*". Mould of tip of umbonal cavity removed to reveal hinge identical with that of thickened *quadrata* shells. x 2.

1b

1a



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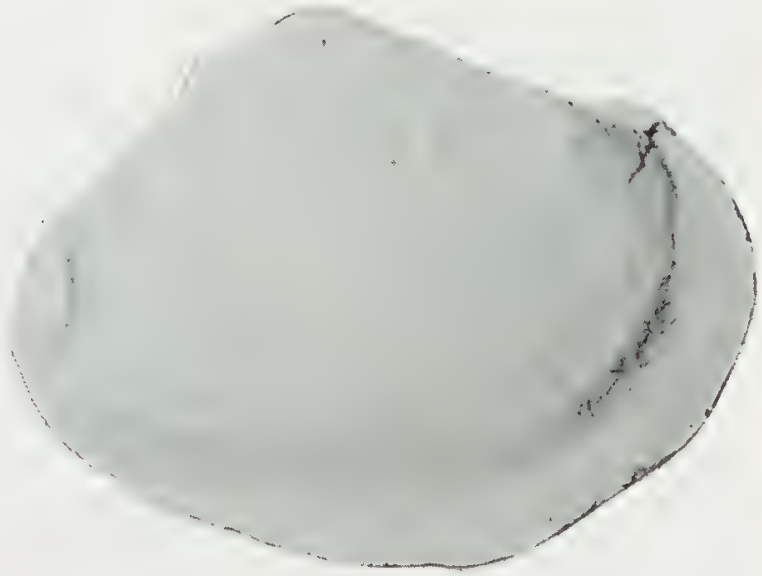

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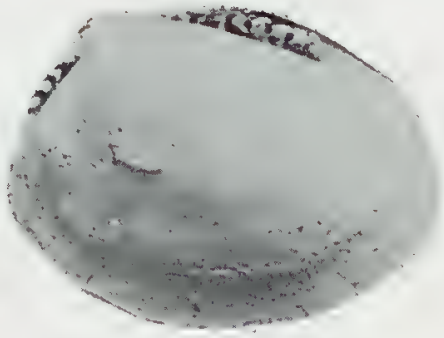

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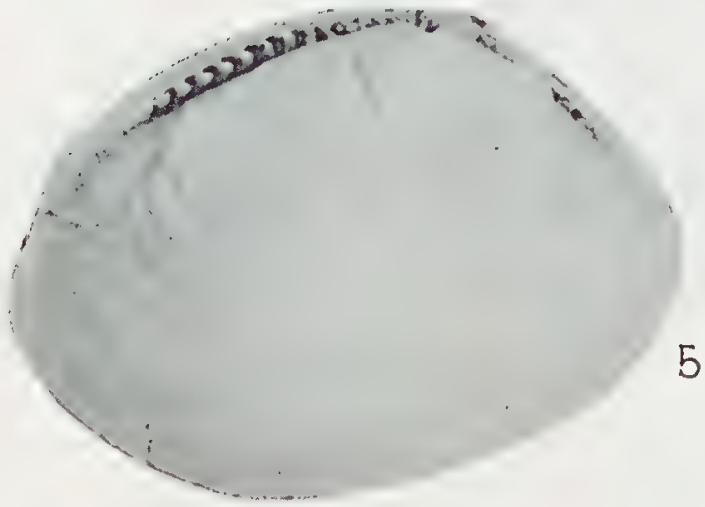

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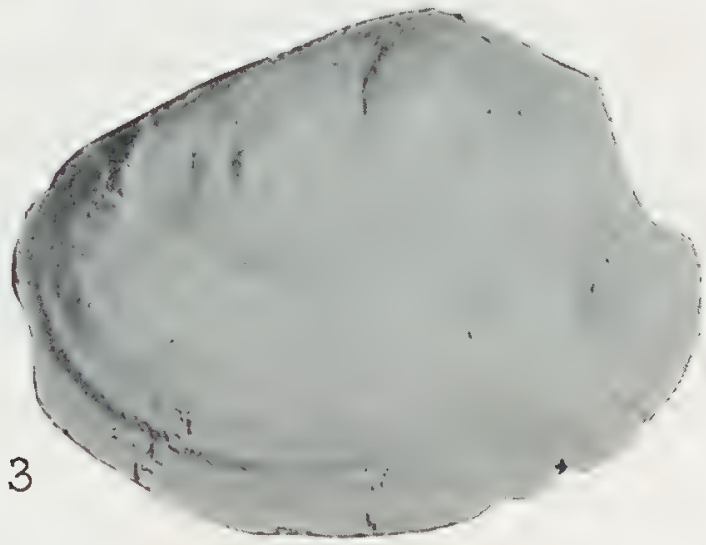

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PLATE 2

EXPLANATION OF PLATE 3

Figs 1–5. Topotypes. *Leionucula quadrata* (Etheridge) 1872.

1. GSQF 6827, latex cast of hinge of left valve with heavy chondrophore tooth and unusually large first mis-shapen tooth. x 2.

2. GSQF 6815. a, internal mould of right valve showing accessory musculature. x 1·5. b, the left valve, with only two anterior pedal muscles. x 2.

3. GSQF 6893. a, internal mould of right valve with mould of umbonal cavity broken, showing hinge. x 2. b, latex cast showing crest of chondrophore tooth set back from edge of chondrophore. x 4.

4. GSQF 6834. a, internal mould of right valve; tip of umbonal cavity mould removed to show hinge. x 1. b, same. x 4.

5. GSQF 6833. a, internal mould of left valve, mould of umbonal cavity removed. x 1. b, same. x 4. c, latex cast showing chondrophore tooth forming margin of chondrophore. x 4.

PLATE 3

EXPLANATION OF PLATE 4

Figs 1–8. *Phaenodesmia elongata* (Etheridge) 1872.

1. QMF 17/1247. Holotype of *Leda elongata* Eth. showing fairly high umbo and shape of posterior end. x 2.

2. GSQF 7136. Topotype. Latex cast of exterior showing fine and regular concentric ornament. x 2.

3. GSQF 7149. Topotype. Predominantly internal composite mould. Hinge of this specimen well preserved. x 2.

4. GSQF 7127. Topotype. Predominantly internal composite mould with produced posterior. x 2.

5. GSQF 7130. Topotype. Internal mould showing possible umbonal muscles, posterior adductor and pallial sinus. x 2.

6. GSQF 9317. From quarry on line near Urraween railway station. Internal mould of right valve showing anterior adductor scar. x 2.

7. GSQF 9323. Same locality as fig. 6. Latex cast of interior of left valve showing uninterrupted row of hinge teeth. x 2.

8. GSQF 9318. Same locality as fig. 6. Latex cast of exterior of small specimen. x 3.

Figs. 9–13. *Phaenodesmia randsi* (Etheridge fil.) 1892.

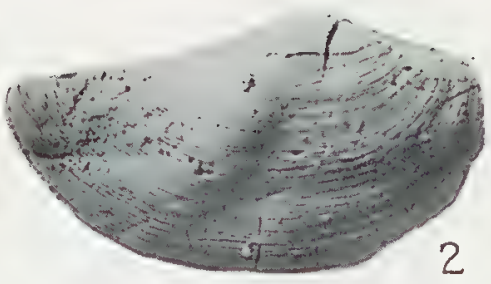
9. GSQF 9319. Same locality as fig. 6. Latex cast of exterior of left valve showing irregular growth lines. Posterior part of escutcheon just showing above carina. x 2.

10. GSQF 7425. From Corporation Quarry. a, internal mould of left and part of right valve of presumably one organism. x 2. b, latex cast. x 2.

11. GSQF 7153. Same locality as fig. 10. Internal mould of right valve laterally compressed, causing displacement of umbo above hinge line. Shows pallial line. x 2.

12. GSQF 7526b. Same locality as fig. 10. Latex cast of part of external dorsal region of two valves of one organism slightly separated. Shows posterior carina, escutcheon, and just behind umbos, area of ligament attachment. x 3·5.

13. GSQF 1410. Holotype. a, lit from above and slightly to the right to show posterior adductor scar and pallial sinus. x 3. b, lit conventionally and showing anterior adductor scar. Point of umbonal cavity at same height as hinge margin. x 2.



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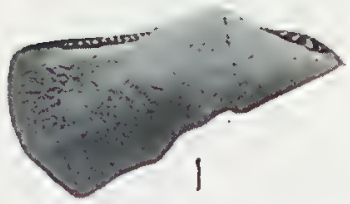

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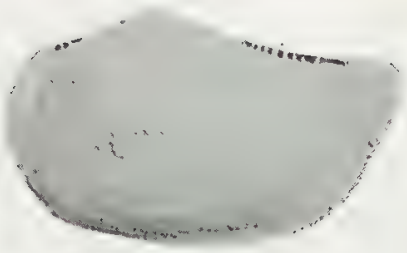

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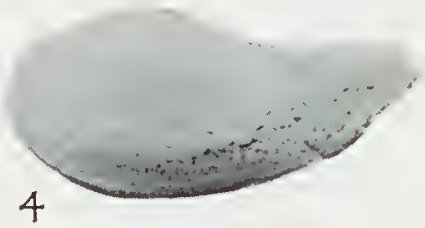

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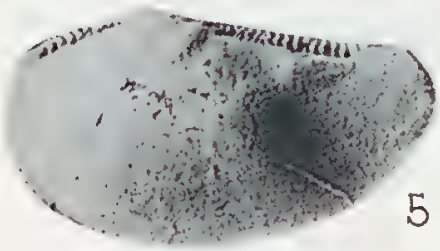

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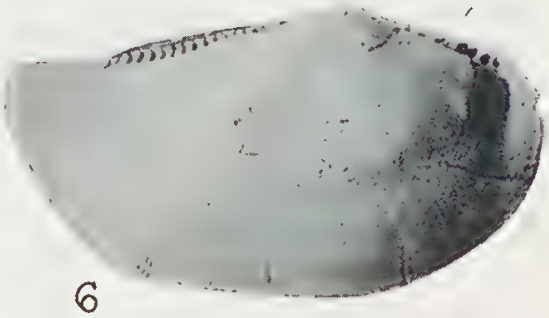

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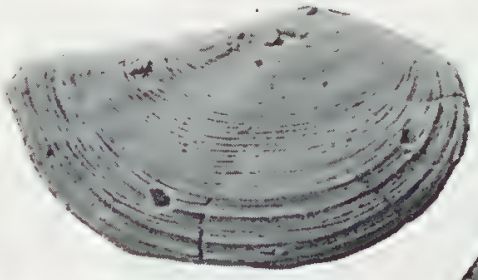

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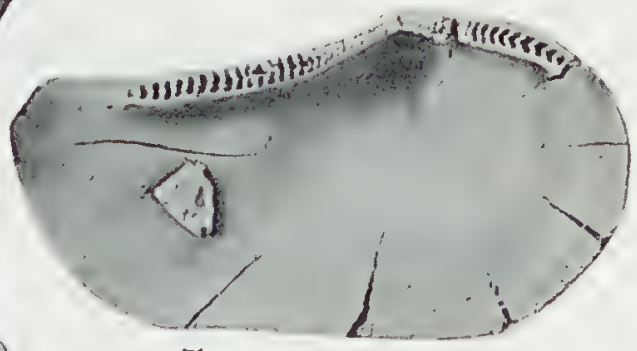

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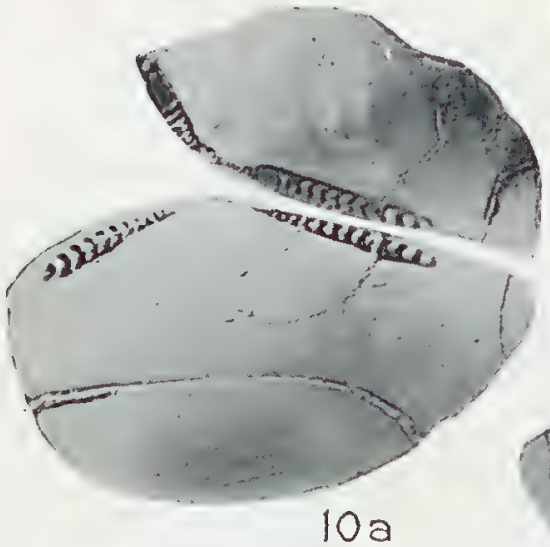

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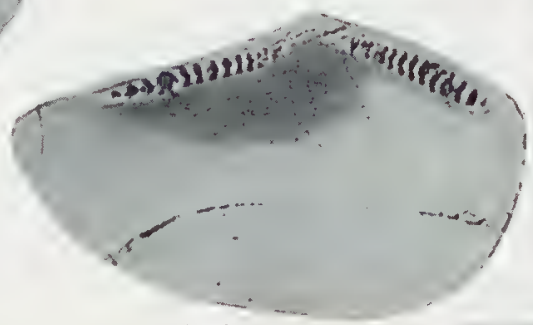

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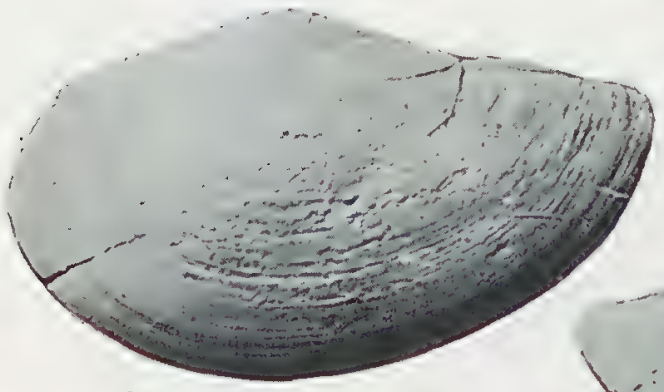

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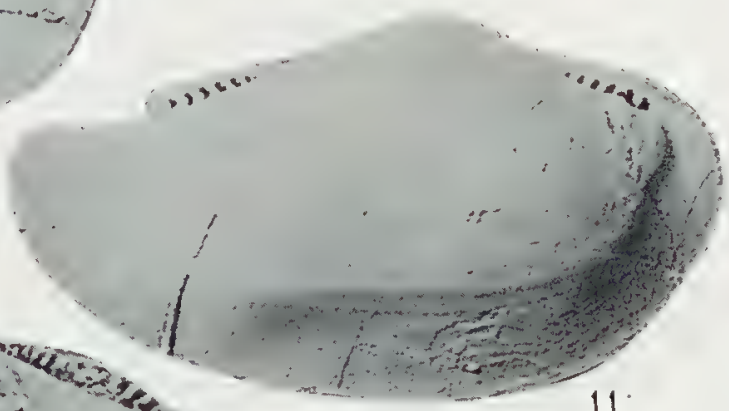

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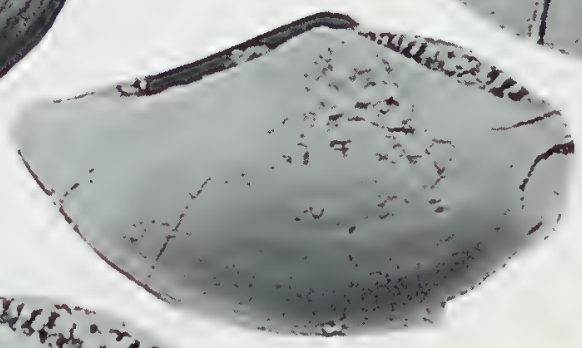

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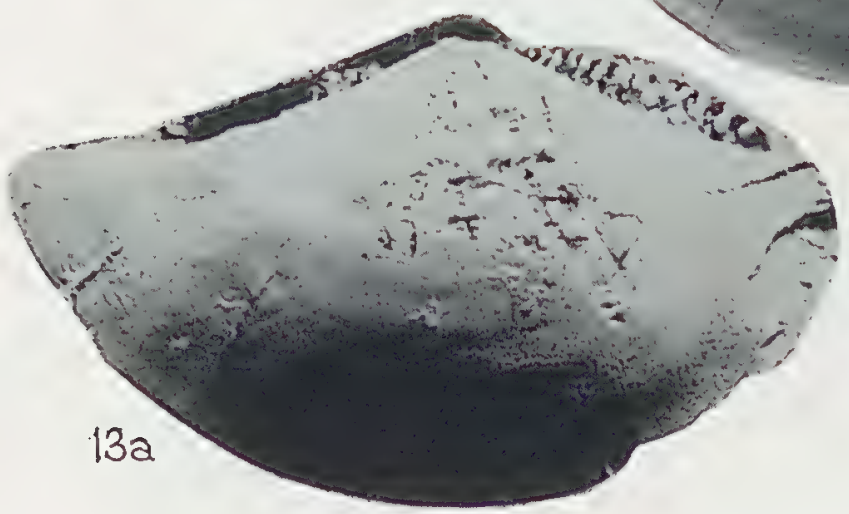

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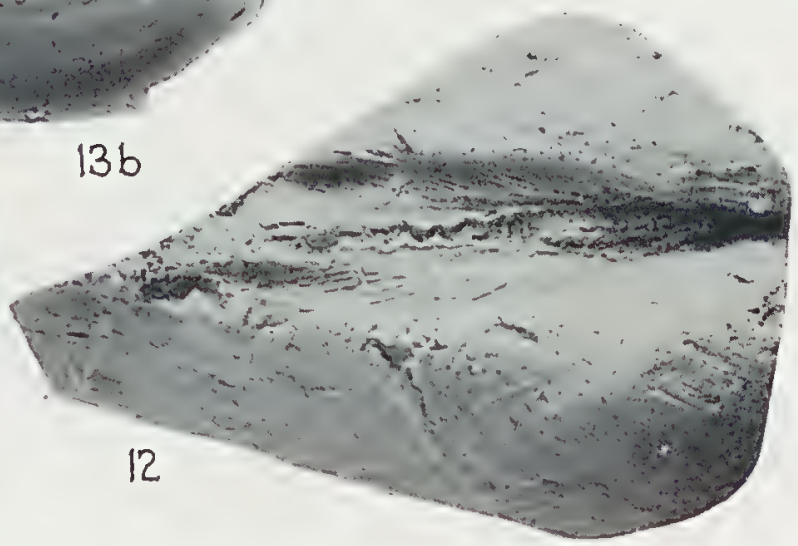

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PLATE 4

EXPLANATION OF PLATE 5

Prefix QM refers to Queensland Museum specimens; GSQ to Geological Survey of Queensland specimens.

Figs. 1–5. *Grammatodon* (*Indogrammatodon*) *robusta* (Etheridge) 1872.

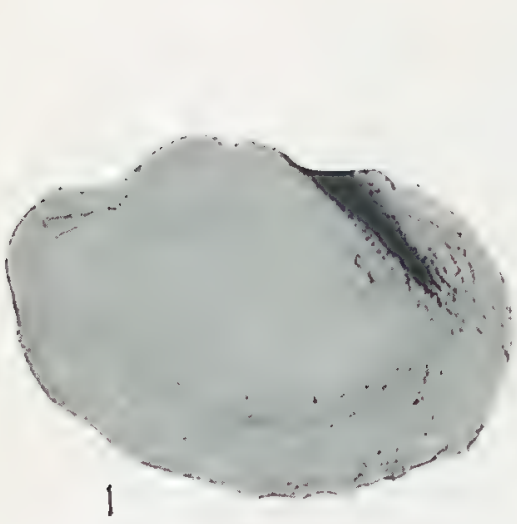
1. GSQF 1403. Topotype. Internal mould of small specimen figured by Etheridge fil. (1892, pl. 26, fig. 4). x 1·5.

2. GSQF 7047. Topotype. Internal mould of very small specimen with traces of both radial and concentric ornament impressed. x 2.

3. QMF 17/1242. Holotype of *Cucullaea robusta*. a, lateral view of valve showing shape and well preserved anterior and posterior teeth. Specimen has a typically broad umbonal region. x 2. b, dorsal view of specimen showing anterior and posterior tooth arrangement. Teeth under umbo distorted. Specimen slightly flattened laterally. x 2.

4. QMF 17/1243. Holotype of *Cucullaea costata*. a, left valve, partly composite mould, badly abraded. x 1·5. b, anterior view showing general shape of left valve and distorted right valve. x 2. c, dorsal view, showing complete absence of hinge characters. x 1·5.

5. GSQF 1402. Topotype. Latex cast of exteriors of parts of right and left valves of specimen figured (from plaster cast) by Etheridge fil. (1892, pl. 26, fig. 1). Shows characteristic ornament of right valve with several ribs intercalated between primaries. x 1·4.



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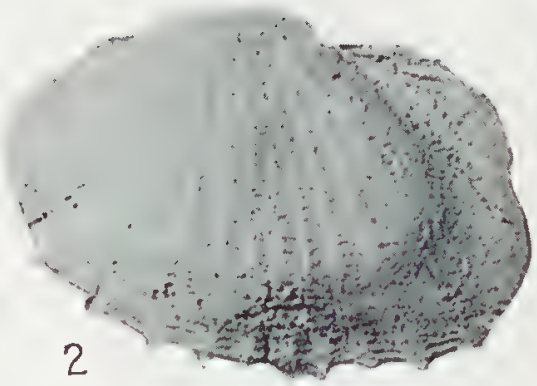

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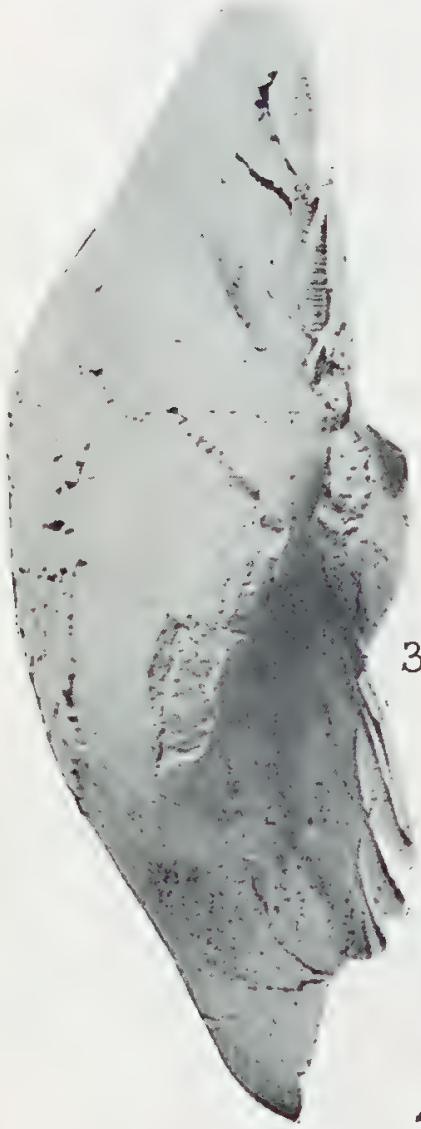

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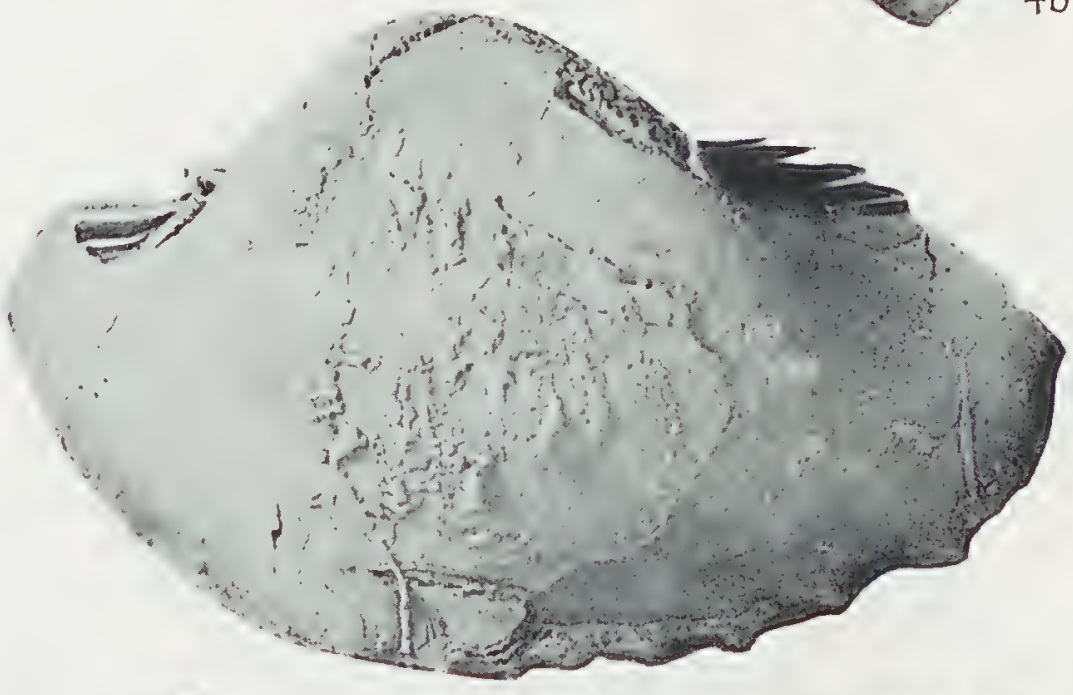

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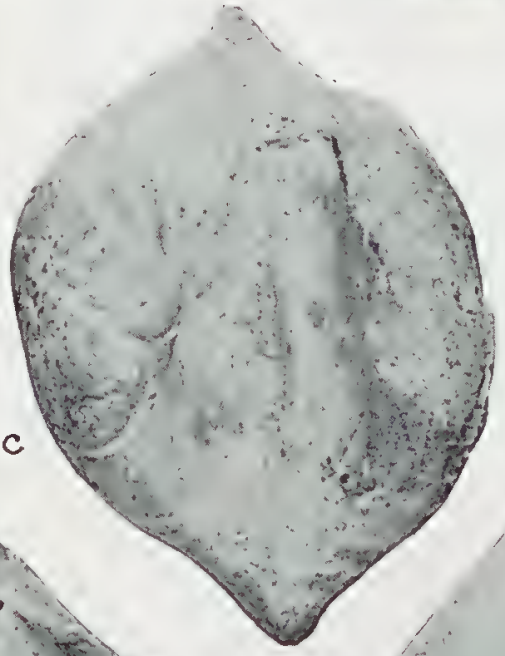

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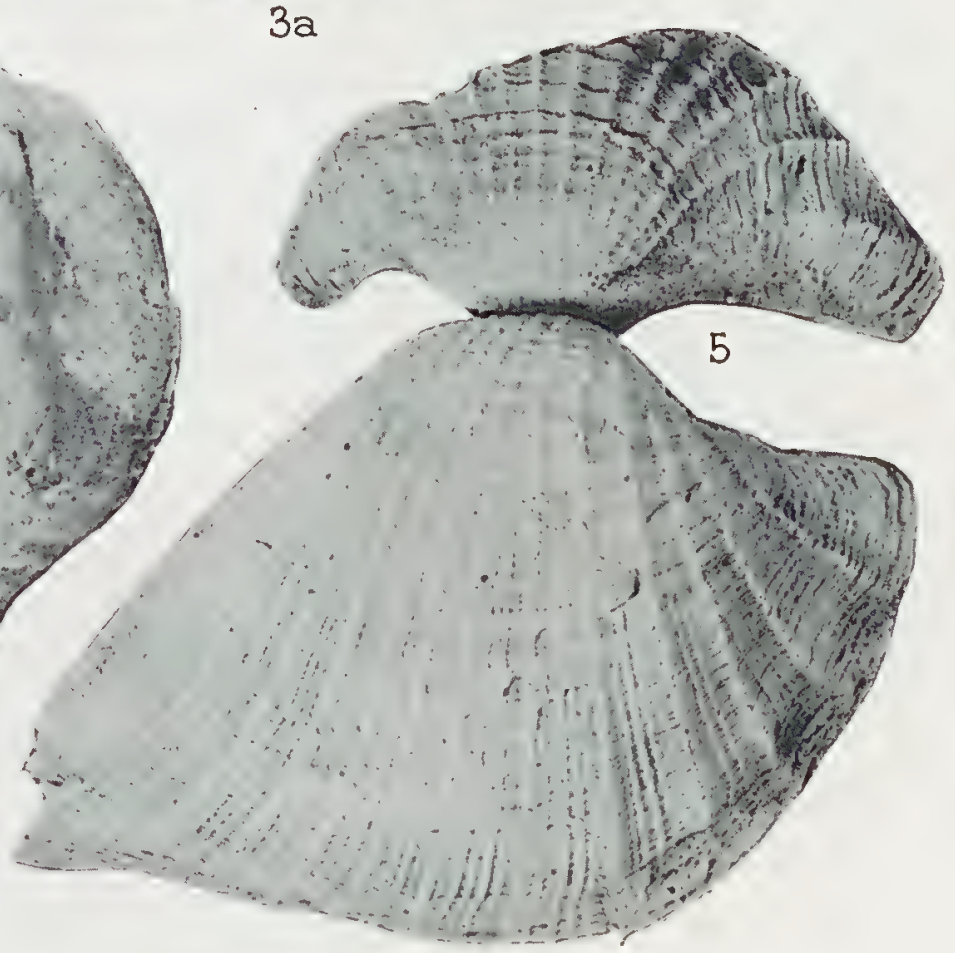

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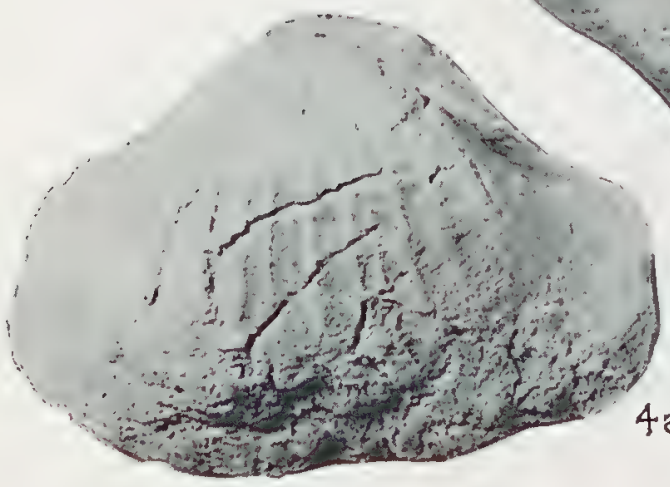

4a

PLATE 5

EXPLANATION OF PLATE 6

Figs. 1–4. *Grammatodon* (*Indogrammatodon*) *robusta* (Etheridge) 1872.

1. GSQF 7038. Topotype. Latex cast of exterior of anterior end of left valve, hinge pointing down to the left. Shows strong primary ribbing, secondary ribbing, and lack or only incipient development of tertiary ribbing. Concentric lamellae pass over radial ribs. x 2.

2. GSQF 7472. Topotype. Latex cast of best preserved hinge. Right valve showing similarity of anterior and posterior dentition, vertical teeth closer to anterior than to posterior end, and long, almost horizontal tooth placed mid-way between vertical teeth and posterior of hinge. x 2.

3. QMF 5472. Queensland Museum specimen, locality Maryborough. a, latex cast of right valve, antero-lateral view, showing multiple intercalated ribs between primaries on lateral parts. x 1. b, latex cast of left valve, antero-lateral view, fewer intercalated ribs than on right valve. x 1. c and d, same casts as in b and a above respectively, lateral views. Primary and secondary ribs of right valve more nearly of equal size than those of left valve. Very weak ribbing on and above carina of both valves. x 1·4. e, internal mould, dorsal view. x 1·3. f, internal mould, anterior view. x 1.

4. GSQF 7048. Topotype. Latex cast of marginal ventral region of exterior of right valve lit from high left to accentuate concentric ornament. x 2.

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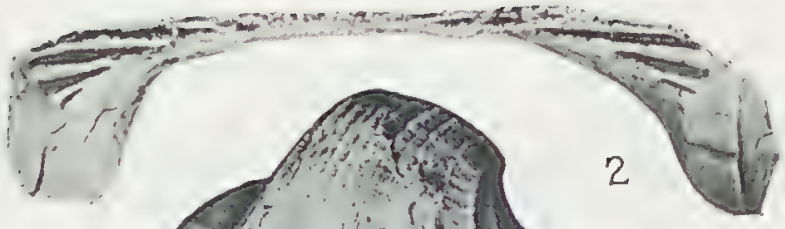

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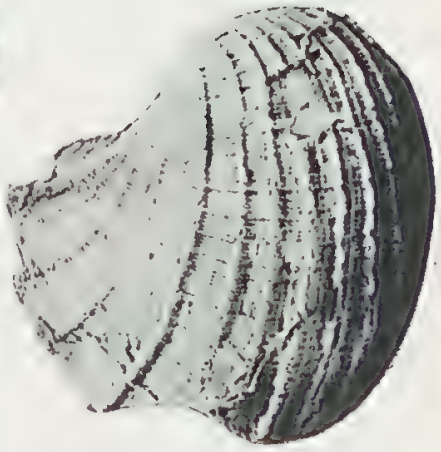

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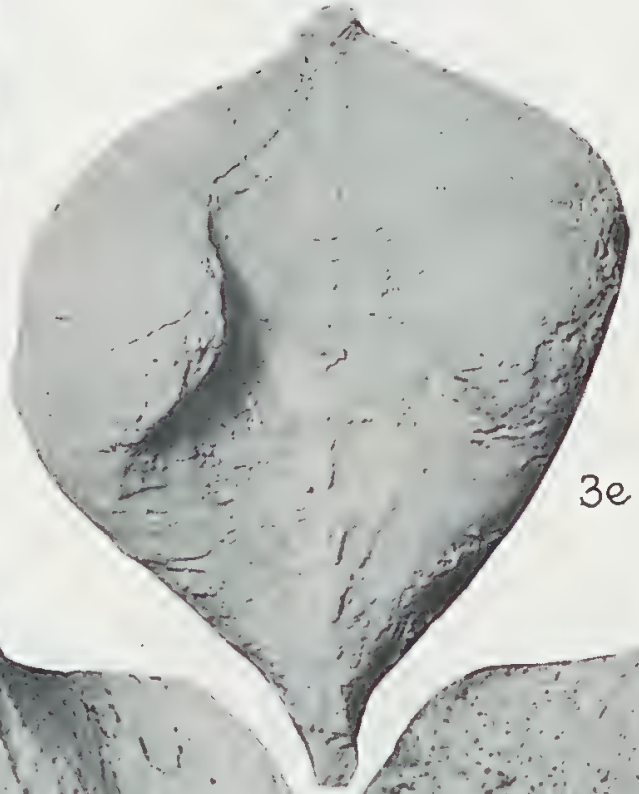

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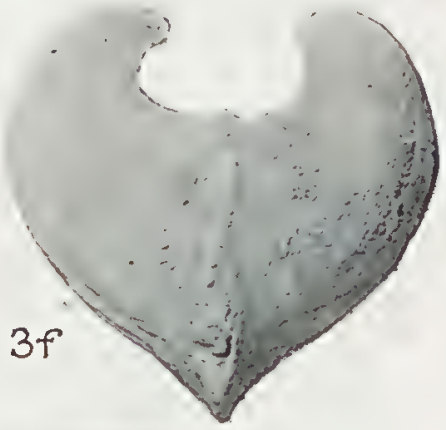

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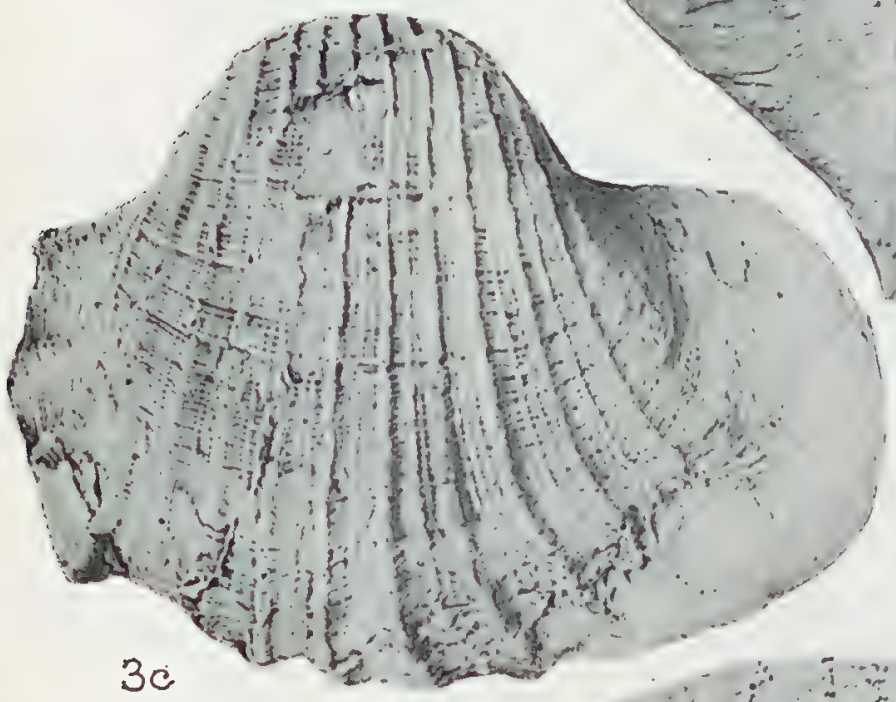

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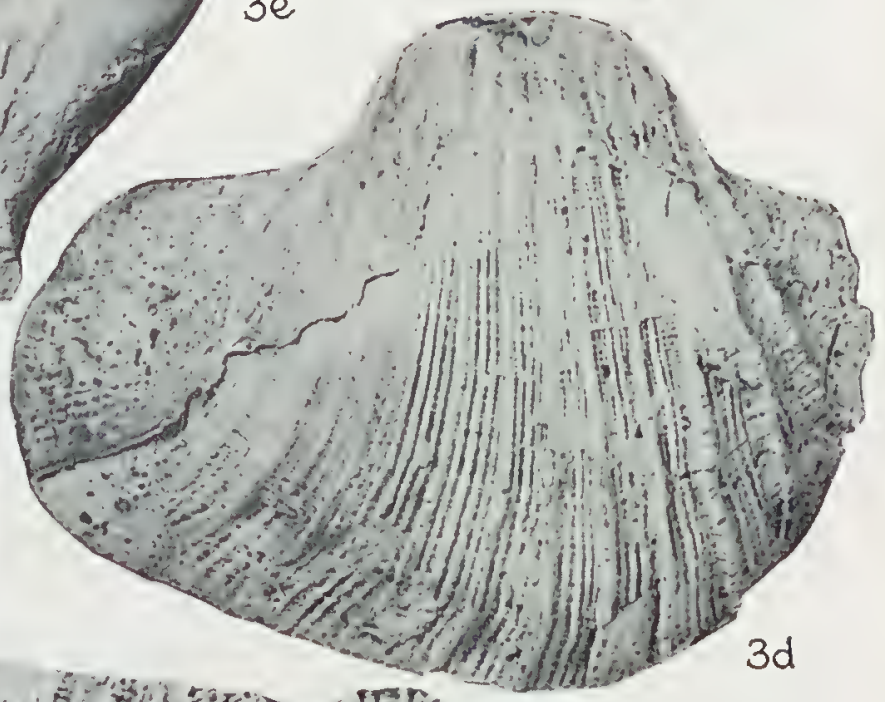

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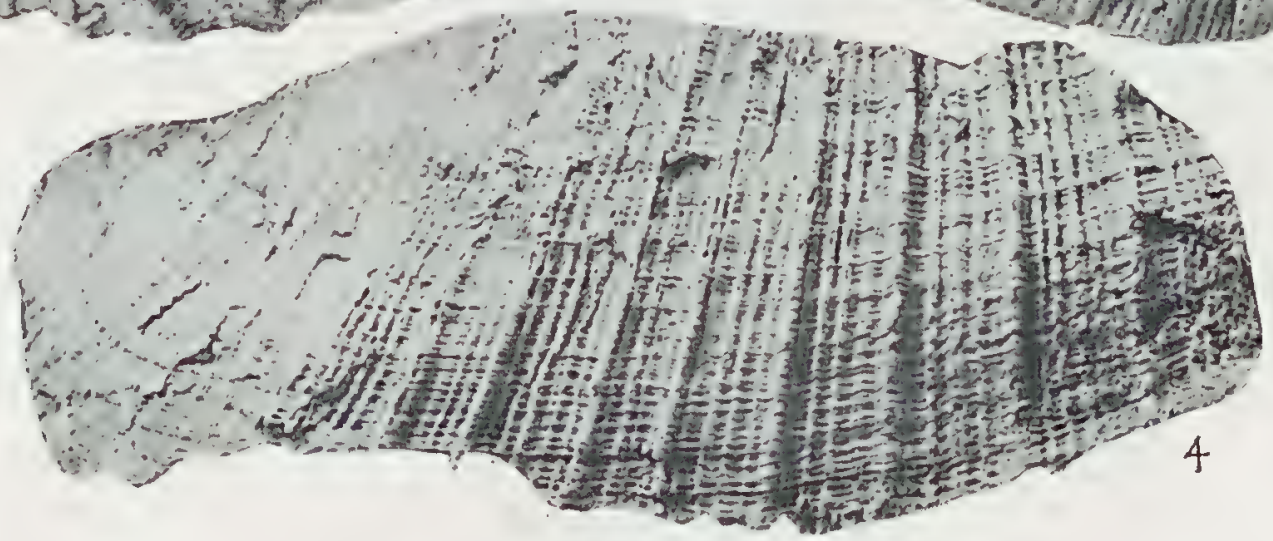


4

PLATE 6

EXPLANATION OF PLATE 7

Figs. 1–3. *"Ctenodonta" cordalbae* sp. nov.

1. Internal mould, right valve. F 8569, holotype. x 9.

2. Internal mould, left valve. F 8566a, paratype. x 5.

3a, b. Internal mould, valves together, dorsal view. F 8565, paratype. a x 4·1, b x 9·3.

Fig. 4. *Nuculopsis* (*Nuculopsis*) sp. Internal mould of right valve of slightly squashed specimen (see text p. 22) viewed from above right. F 8251. x 5·6.

Fig. 5. *Nuculopsis* (*Nuculanella*) sp. Internal mould of right valve with infilling of apex of umbonal cavity broken. F 8250. x 7·5.

Fig. 6. *Myalina* sp. Internal mould of right valve lit from above right. F 6482a. x 2·1.

Figs 7–12. *Bakevellia capricorni* sp. nov.

7. Internal mould of slightly crushed, thickened right valve with deeply impressed pallial line and posterior adductor scar. F 8239. x 2.

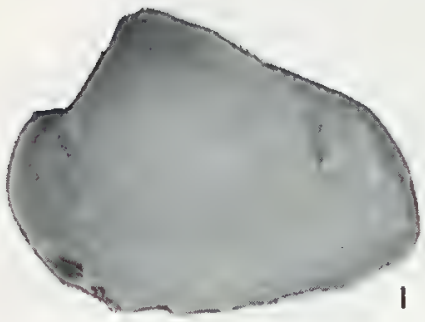
8. Edentulous right valve with deep ligament pits on thick hinge margin. Latex cast. F 8263. x 2·2.

9. Erect left valve with strong lateral teeth and anterior musculature. a, internal mould; b, latex cast. F 8259. x 2·2.

10. Internal mould of thickened left valve showing position of posterior adductor scar and strong anterior buttress. F 8256. x 2.

11. Latex cast of left valve exterior; anterior incomplete. F 8240a, paratype. x 2·3.

12. Left valve with anterior cardinal teeth and small buttress; single posterior lateral tooth. a, internal mould; b, latex cast. F 8255, holotype. a, x 1·9, b, x 2·3.



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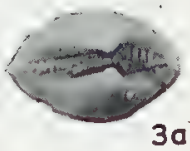

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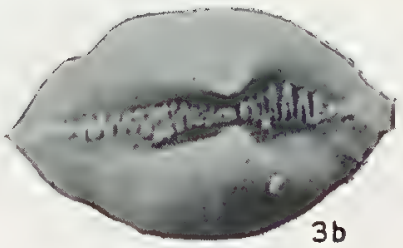

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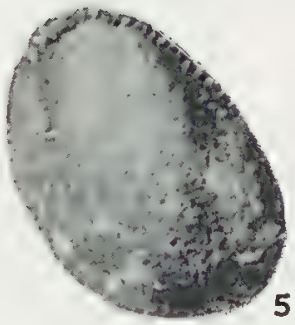

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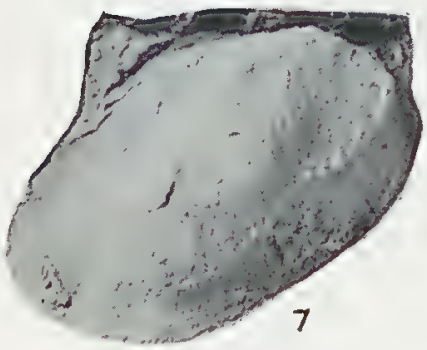

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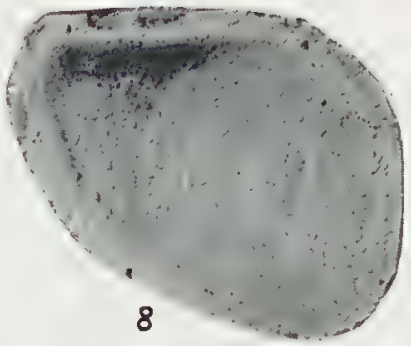

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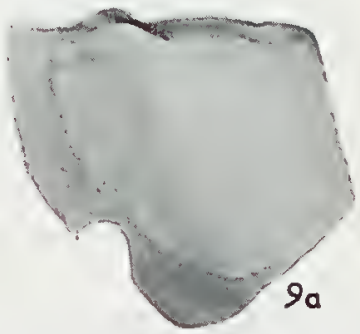

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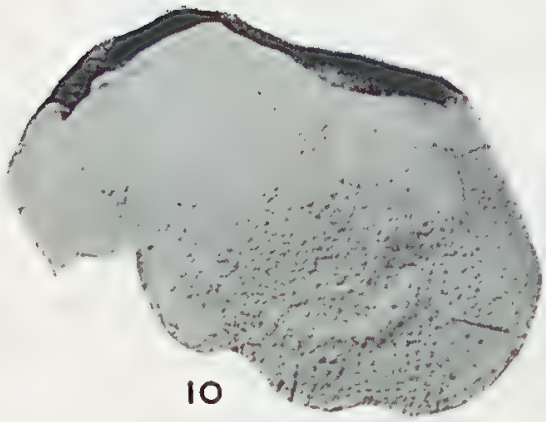

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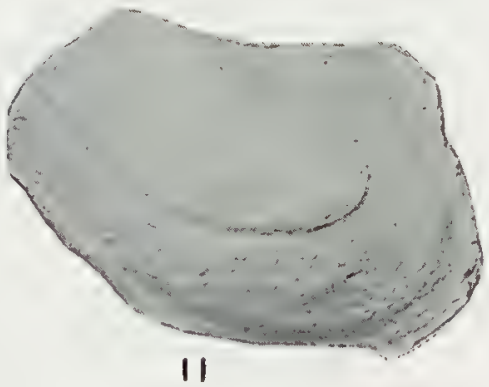

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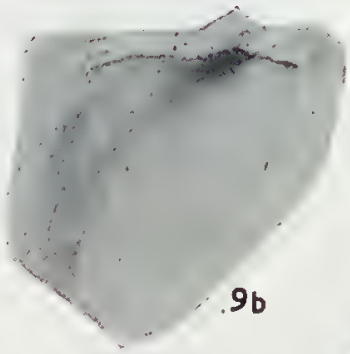

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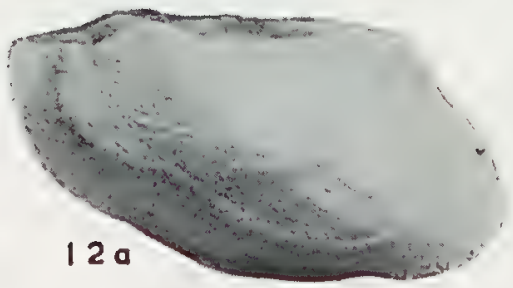

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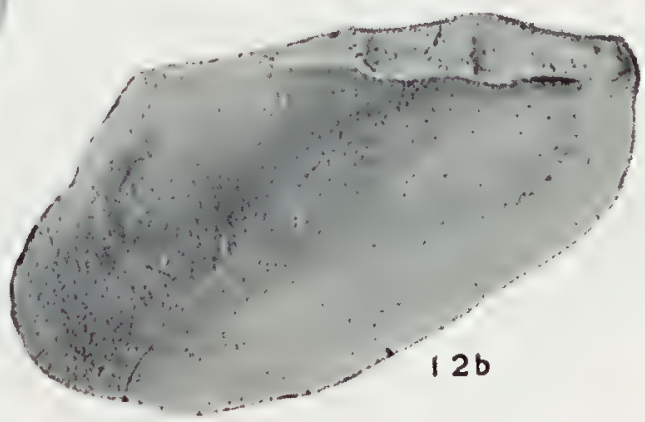


12b

PLATE 7

EXPLANATION OF PLATE 8

Figs 1–7. *Bakevellia capricorni* sp. nov.

1. Latex cast of right valve exterior lit from lower right to show growth lines in postero-dorsal region; anterior incomplete. F 8829. x 2.

2. Right valve interior with large buttress and strong cardinal dentition, one lateral tooth and four ligament pits. a, internal mould; b, latex cast. F 8253, paratype. a, x 1·8, b, x 2·2.

3. Internal mould of fairly erect right valve with strong posterior lateral tooth; anterior incomplete. F 8273, paratype. x 1·8.

4. Internal mould of right valve with multiple posterior lateral teeth; position of pallial line and posterior adductor scar shown; antero-dorsal margin incomplete. F 8879, paratype. x 2·1.

5. Internal mould of left valve with strong buttress and deep anterior pedal muscle scar. F 8268. x 2·2.

6. Internal mould of edentulous right valve with very short hinge. F 8270. x 2·1.

7. Internal moulds of two left valves with strong anterior buttresses. F 6182. x 1·9.

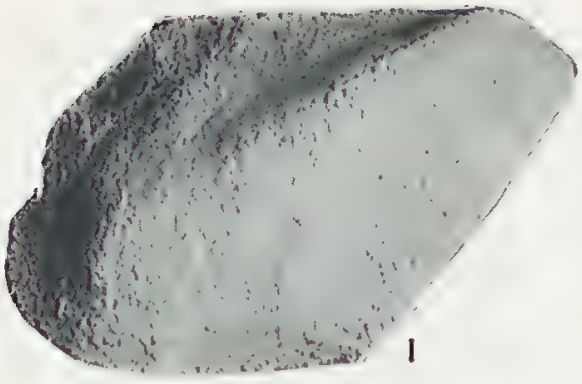
Fig. 8. *Bakevellia* sp. a, internal mould of tumid left valve. x 3. b, latex cast showing transverse teeth along hinge behind and in front of umbo, x 5. F 9494a.

Fig. 9. ? *Schizodus* sp. Latex cast of left valve interior showing two blunt cardinal teeth with socket between. F 8247. x 4.

Figs 10–11. *Neoschizodus teres* sp. nov.

10. Left valve interior showing deeply impressed pallial line and heavy dentition. a, mould lit from right to show width of base of buttress; b, latex cast of upper half. F 9063, paratype. a, x 2·4, b, x 2.

11. Latex cast of left valve interior with good preservation of dentition. F 8230, holotype. x 2.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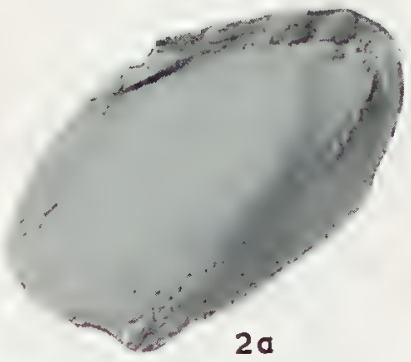
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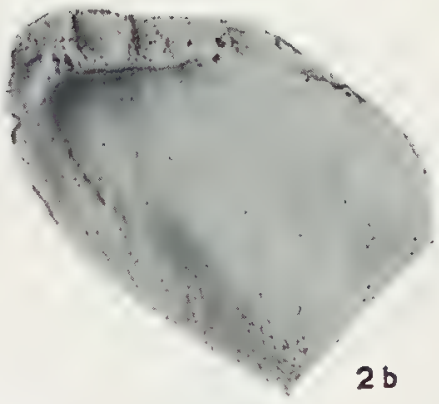
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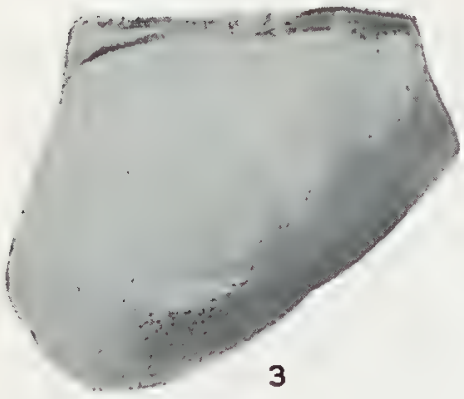
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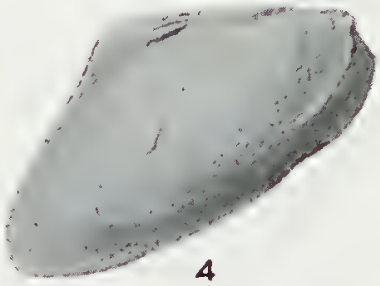
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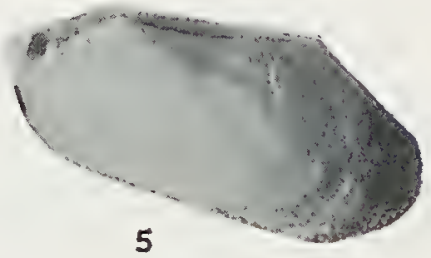
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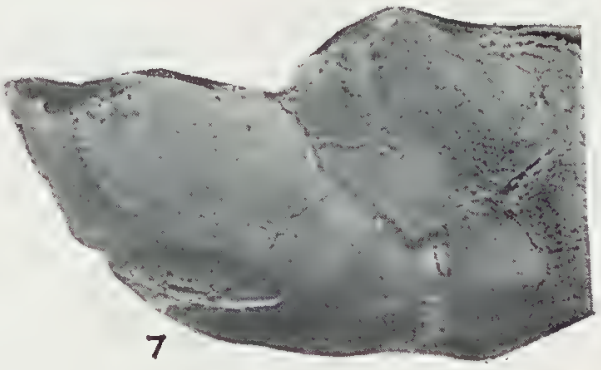
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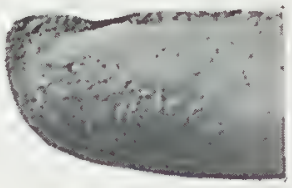
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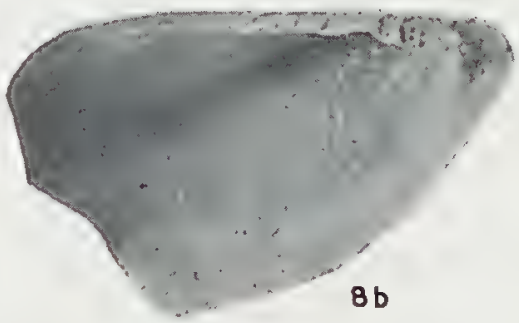
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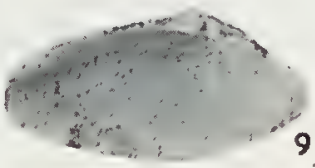
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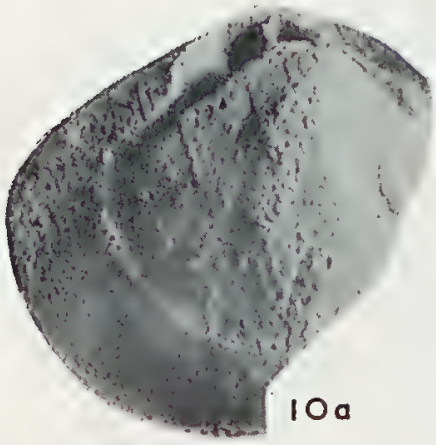
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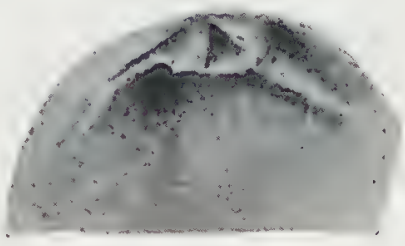
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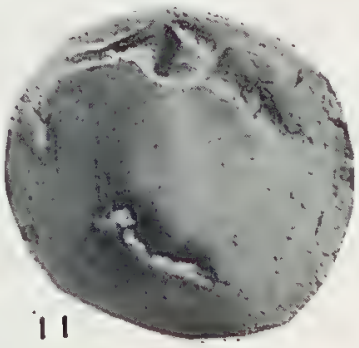
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PLATE 8

EXPLANATION OF PLATE 9

Figs 1–7. *Neoschizodus teres* sp. nov.

1. Exterior of left valve with sand grains adhering to shell; ventral margin incomplete; shows carina of undistorted shell. F 8633. x 2·1.

2. Latex cast of left valve slightly crushed from front to back; dentition not as heavy as in holotype. F 8227, paratype. x 2·1.

3. Latex cast of right valve with strong dentition; teeth 3a and 3b contiguous under umbo. F 8228, paratype. x 2·3.

4. Exterior of elongated left valve slightly crushed top to bottom. F 8232. x 1·3.

5. Internal mould of paired valves, anterior to the right, showing tumidity. F 8225b. x 2·2.

6. Group of internal moulds; typical appearance at type locality. F 8231b. x 1·2.

7. Group of internal moulds of left valves showing range of shapes produced by earth-movement. Elongation has occurred approximately in the direction indicated by the arrow. F 6233. x 2.

Fig. 8. Astartid aff. *Eoastarte*. Small internal mould with inadequately preserved dentition for detailed comparison. On F 8251. x 3·6.

Fig. 9. Group of minute bivalve shells including nuculids, *? Schizodus*, and *? Eoastarte*, typical of the locality at L 445. F 8247. x 1·4.

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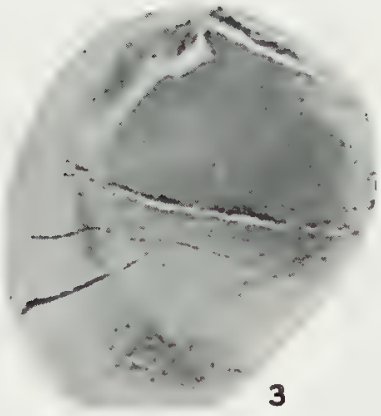

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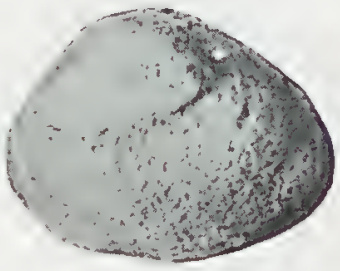

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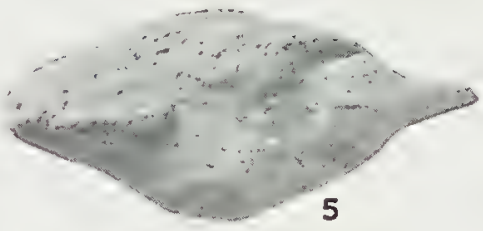

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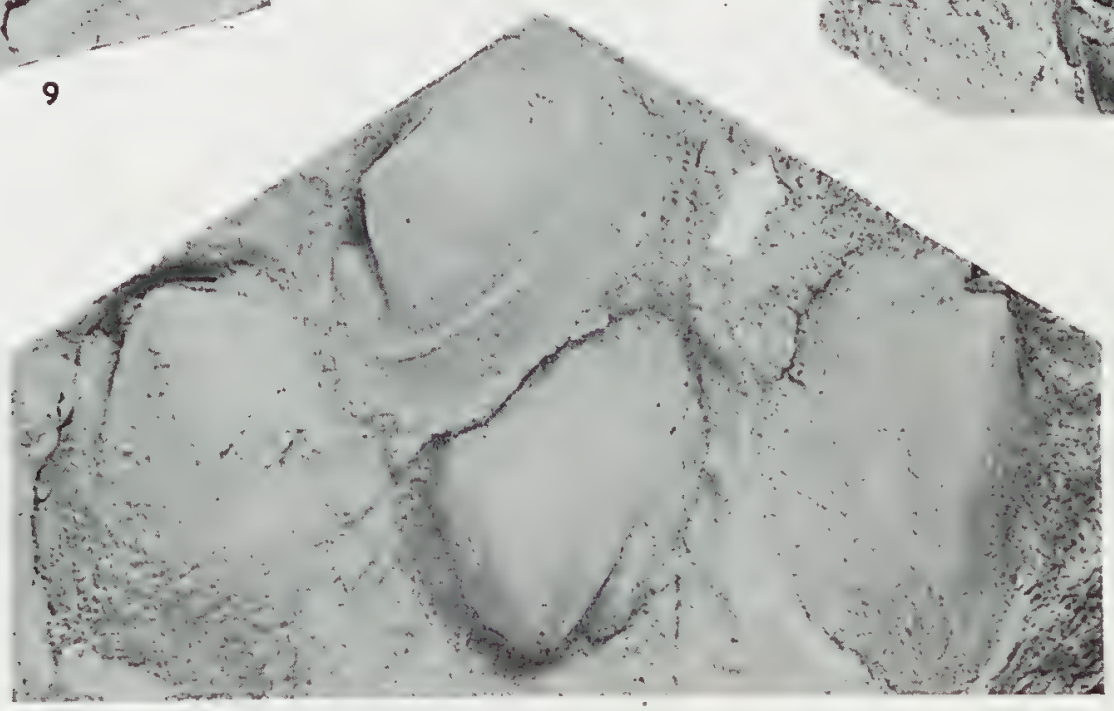

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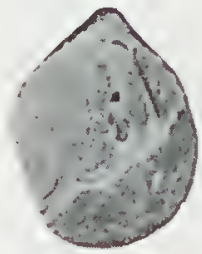

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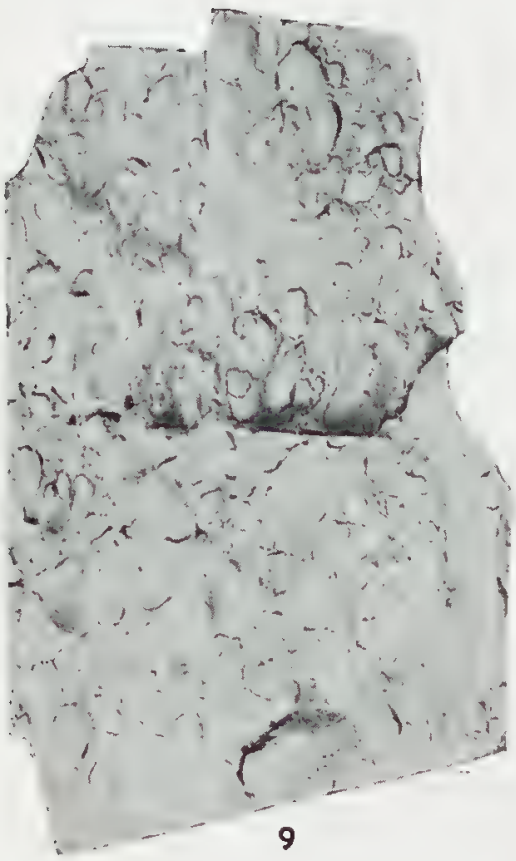

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PLATE 9

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DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.Sc., Chief Government Geologist)

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DEVONIAN SPORES FROM THE ADAVALE BASIN

by
N. J. de JERSEY

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ABSTRACT

Microfloral assemblages from nineteen samples of Devonian sediments from the sub-surface of the Adavale Basin, in western Queensland, have been studied. With one exception, these came from the Etonvale Formation; the samples cover a sequence, about 3,000 feet in thickness, in this formation. The remaining sample was from the overlying Buckabie Formation. From these samples, thirty-nine species of miospores are recorded; of these, twelve are proposed as new species and one as a new combination. The remainder are either identified, or compared with species previously described from the Devonian, or not formally designated. One new genus, *Heterotruetes*, is proposed, as well as formal emendation of *Schopfites* Kosanke.

The stratigraphic distribution of the species within the Etonvale Formation is discussed and illustrated by diagrams, based on two well sections. Microfloral evidence supports that of the associated marine faunas, in assigning a Middle Devonian age to the Etonvale Formation; the lower part of the overlying Buckabie Formation is also regarded as Devonian. The microfloras of the Etonvale Formation are shown to be older than those previously recorded from the Devonian of Australia; they constitute the oldest assemblages of dispersed spores yet described from the Southern Hemisphere. Comparison with assemblages from the Northern Hemisphere reveals marked differences which are attributed to environmental differences in Middle Devonian times.

INTRODUCTION

The presence of Devonian sediments, underlying younger strata in the region of Adavale, in western Queensland, was first revealed by the Phillips–Sunray Etonvale No. 1 well, completed in March, 1962. Since then other wells have penetrated Devonian strata in this region; from the lithological sequences recorded in them, together with evidence from geophysical methods, the broad outlines of the stratigraphy and structure of these Palaeozoic sediments have emerged. As indicated by Heikkila (1965) "the Adavale Basin is one of several remnant Palaeozoic basins underlying the Mesozoic and Permian of the Great Artesian Basin. Three other basins or large synclinal troughs, the Quilpie, Cooladdi and Westgate troughs, have a similar history and stratigraphic sequence to the Adavale Basin. All were parts of a once more extensive Palaeozoic basin of deposition on the western side of the Tasman geosynclinal complex."

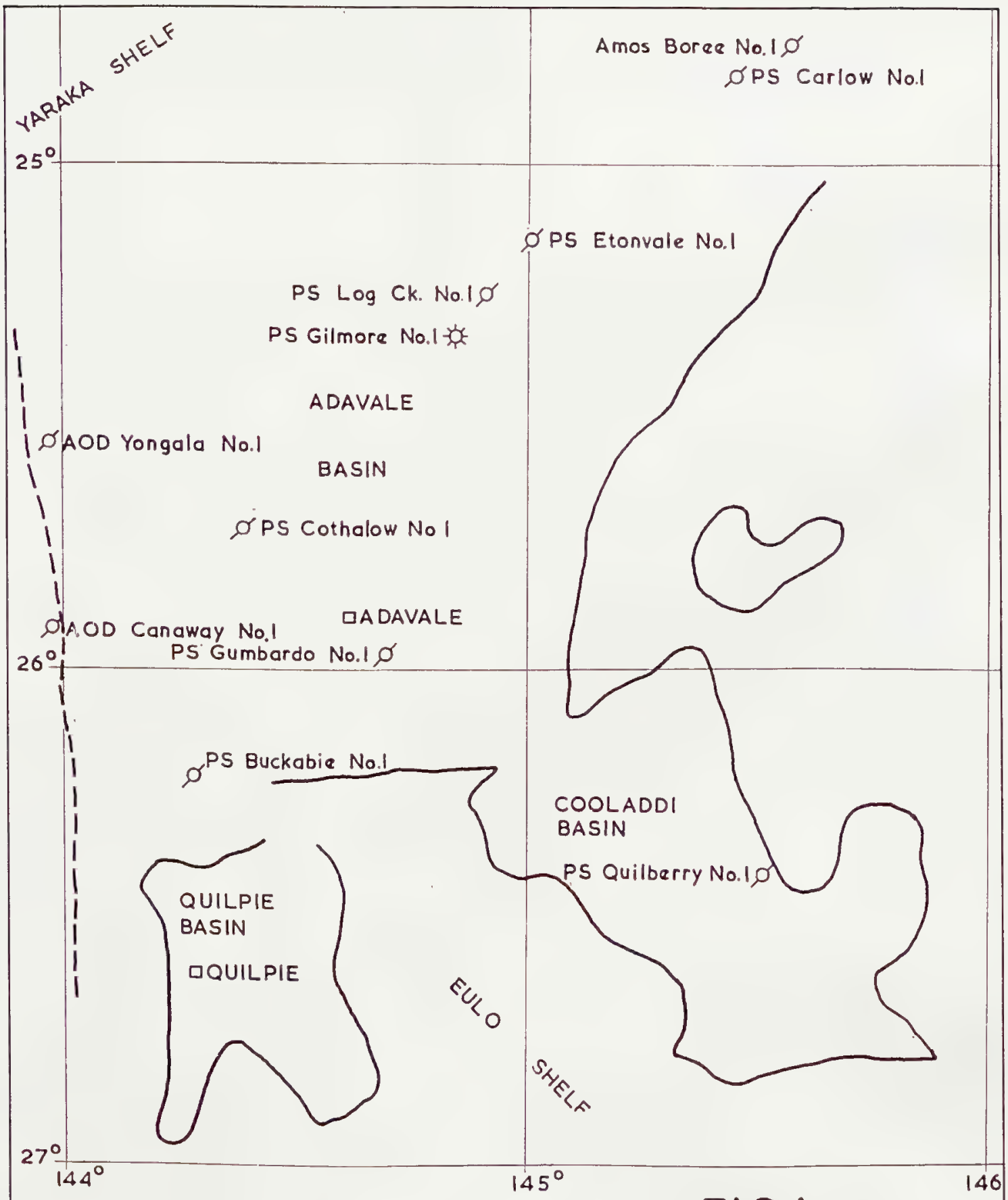
The economic importance of this Devonian sequence was indicated by the discovery, during 1964, of a significant flow of natural gas in the Phillips–Sunray Gilmore No. 1 well. At the time of writing, development drilling is in progress on the Gilmore structure. It is evident that this discovery has stimulated exploratory drilling in the Adavale Basin and that as a result there will be a considerable advance in detailed stratigraphic knowledge of the sediments.

The Devonian age of the Etonvale Formation has been established by studies of its marine faunas, as well as by the investigation of the microfloras, recorded here. In Australia, Devonian microfloras have been described from Western Australia by Balme (1960) and Balme and Hassell (1962) and from the Northern Territory by Hodgson (1964). The spore assemblages recorded in this paper thus constitute the first Devonian microfloras to be described from Queensland. Accordingly the principal objectives of this investigation have been to record descriptions of the species present, to discuss microfloral evidence on the age of the sediments and to compare the assemblages with those from the Devonian in other parts of the world. Finally, the microfloral sequences in the well sections have been studied so as to delineate the stratigraphic distribution of the species and so provide a basis for correlation studies in the Adavale Basin.

STRATIGRAPHIC DISCUSSION

A general account of the stratigraphy and structure of the Adavale Basin (based on data available up to February, 1965) has been published by Heikkila (1965). The Devonian sediments, assigned to the Adavale Group, comprise the Etonvale and Buckabie Formations. The lower unit, the Etonvale Formation, is a partly continental, mainly shallow marine sequence with a maximum thickness of the order of 5,000 ft. (Heikkila, 1965.) It is overlain by the Buckabie Formation, which is a "red-bed" sequence, consisting of multi-coloured shale, siltstone and sandstone, with a maximum thickness of 10,000 ft. It is largely devoid of fossil remains; a continental and shallow marine environment of deposition has been suggested by Heikkila (1965).

The same author has recorded several sub-units (of member status) within the Etonvale Formation and has indicated their dominant lithology. The most significant of these, from the aspect of correlation, is the D3 carbonate member, which constitutes a persistent marker bed through much of the area of the basin. It is also the best pre-Permian seismic reflector in the sequence. Heikkila (1965) points out that "the D3 carbonate obviously reflects



LEGEND

Known margin of Devonian sediments

Probable margin of Devonian sediments

Dry hole.

Gas well.

FIG 1
WELL LOCATIONS ADAVALE BASIN

SCALE OF MILES
0 10 20 30

After Phillips Petroleum Co.

more stable sedimentary conditions" and suggests that there may be a slight time break between it and the underlying sediments.

A volcanic unit, the Gumbardo Formation, underlies the middle part of the Etonvale Formation in the Phillips–Sunray Gumbardo No. 1 well. It consists o 2,400 ft. of acid tuffs. The age assigned to the upper part of this unit by the potassium-argon method is 380 million years. On the basis of the time scale given by McDougall and Leggo (1965, p. 297) this would place the upper part of the Gumbardo Formation as Middle Devonian. Heikkila (1965) has suggested that the unit may be the lateral equivalent of the lower part of the Etonvale Formation. Such a correlation would thus favour a Middle Devonian age for that formation. Alternatively, if the Etonvale Formation overlies the volcanic sequence disconformably or unconformably a Middle Devonian or younger age could be indicated for the middle and upper Etonvale Formation in the Gumbardo well.

One other age determination is of interest; this is the dating of the basement granite in the Etonvale well as Upper Silurian (by the rubidium-strontium method). If the overlying Etonvale Formation is regarded as Middle Devonian, as suggested above, then denudation, leading to exposure of this granite at the surface, is presumed to have been in progress during the Lower Devonian.

The known boundaries of the Adavale Basin are indicated on the locality map (Figure 1). These boundaries are delimited to the east and south by unconformities with basement and by faulting on the western side. On the north-west flank successive members of the Etonvale Formation are believed to onlap progressively a north-western basement high—the Yaraka Shelf of Heikkila (1965). Additional geophysical investigations are required to delineate accurately the margin of the Basin in this north-western region.

In the Adavale Basin the Devonian strata are known only from the sub-surface, being covered by a thick blanket of sub-horizontal Permian, Mesozoic and Cainozoic sediments. The nearest Devonian sediments known in outcrop are about 150 miles to the north-east in the Drummond Basin. It has been suggested by the geologists of Phillips Petroleum Co. (1964) that the Adavale Group was originally continuous with these Devonian sediments of the Drummond Basin. Further sub-surface stratigraphic studies are required to confirm this suggestion.

Marine faunas so far recorded from the Etonvale Formation comprise rugose and tabulate corals, brachiopods, pelecypods, gasteropods, conodonts and fragmentary nautiloids and crinoids. Plant remains (mainly referable to the genus *Hostimella*) have also been reported. The most precise age determinations are those based on rugose corals and brachiopods from the Phillips–Sunray Quilberry No. 1 well. A Givetian age was indicated by the fauna of Core 15 (8042-8048 ft.) from this well (McKellar, 1965c). The fauna of Core 9 (5413–5422 ft.) was regarded as Middle Devonian (McKellar, 1965b), while that of Core 8 (5267–5270 ft.) "may be regarded as Givetian or Frasnian in aspect, but probably most closely comparable with that of the Givetian Fanning Limestone (and contiguous sediments) in Queensland" (McKellar, 1965a). Correlation of this section in the Quilberry well with sequences in other wells is based on the presence of limestone between the depths of 5400 and 5600 ft., regarded as equivalent to the D3 carbonate member on lithological and microfloral evidence (de Jersey 1965).

Other faunal studies pertinent to the age of the Etonvale Formation are those of McKellar (1965d) and Hill (1965). The former has suggested a Devonian (Emsian, or more probable, Eifelian) age for a faunule from an unnamed shale member in the Etonvale well, below the D4 unit of the Etonvale Formation. He notes (McKellar, 1965d, p. 3) that "this Devonian age for the unnamed shale member displaces a late Silurian age, originally suggested in an unpublished report (Day and McKellar, 1962) that has subsequently found its way into the literature" (Heikkila, 1965). Support for the Devonian age assigned to this unnamed shale member is provided by a study of tabulate corals from a section in the Phillips–Sunray Gilmore No. 1 well, correlated with this section at Etonvale. A Lower or early Middle Devonian age was suggested for this coral fauna (Hill 1965)—Appendix to Completion Report on P. S. Gilmore No. 1 (Lewis and Kyranis 1965).

The conclusion, drawn from these faunal studies, is that they strongly favour a Middle Devonian age for the Etonvale Formation. This assignment to the Middle Devonian is supported by age determinations by radioactivity methods. Within the Middle Devonian a Givetian age is favoured for the section overlying the D3 member; the section below this member has yielded a Givetian fauna (Core 15 of the Quilberry well) and, from the Etonvale well, a fauna of slightly older (probable Eifelian) aspect. The faunal evidence is as yet too tenuous to establish whether this lower section is slightly diachronous from the eastern to the western side of the basin, or whether in its thicker developments (as at Etonvale) it includes both Eifelian and Givetian sediments. The contribution of microfloral studies to this problem and generally, in providing evidence on the ages of the Etonvale and Buckabie Formations, is discussed below (in the section entitled "Age of the Microfloras").

SAMPLES EXAMINED

The investigation was based on portions of conventional cores from exploratory wells in the Adavale Basin, the positions of which are indicated in the locality map (Figure 1). Data on depths, lithology, core numbers and number of spore specimens studied, are recorded below in Table 1. Of the samples processed, only those giving significant yields of well preserved spores are recorded; the other samples which were macerated were barren or almost barren or yielded spores in a poor state of preservation.

TABLE 1—DATA ON SAMPLES EXAMINED

Well	Core No.	Depth to top of sample ft.	Depth to top of sample in.	Lithology	Specimens studied
P.S. Etonvale No. 1 ..	16	8,058	11	Shale	200
P.S. Etonvale No. 1 ..	17	8,278	5	Shale	200
P.S. Etonvale No. 1 ..	18	8,441	8	Shale	200
P.S. Etonvale No. 1 ..	20	8,767	0	Shale	500
P.S. Etonvale No. 1 ..	21	9,095	4	Shale	200
P.S. Etonvale No. 1 ..	22	9,333	3	Shale	400
P.S. Etonvale No. 1 ..	23	9,610	0	Carbonaceous shale	500
P.S. Etonvale No. 1 ..	24	10,002	0	Carbonaceous shale	200
P.S. Gumbardo No. 1 ..	5	8,336	1	Shale lenticles in sandstone	500
P.S. Gumbardo No. 1 ..	6	8,705	0	Shale	500
P.S. Gumbardo No. 1 ..	10	9,561	5	Shale	500
P.S. Gumbardo No. 1 ..	11	9,898	0	Shale	100
P.S. Gumbardo No. 1 ..	12	10,318	0	Shale	500
Amoseas Boree No. 1 ..	10	4,776	0	Shale	less than 100
Amoseas Boree No. 1 ..	17	6,206	0	Shale	500
P.S. Gilmore No. 1 ..	9	10,937	6	Carbonaceous shale	500
P.S. Gilmore No. 1 ..	16	12,847	8	Carbonaceous shale	100
P.S. Quilberry No. 1 ..	10	5,932	4	Shale	less than 100
P.S. Log Creek No. 1 ..	23	14,351	7	Shale	less than 100

EXPERIMENTAL METHOD

The technique used for maceration of the samples was similar to that previously described (de Jersey and Paten 1964, pp. 1, 2). The samples were first treated with dilute hydrochloric acid to remove calcium carbonate, if necessary. Silicates were then decomposed by heating in hydrofluoric acid at its constant boiling point concentration, aluminium fluoride formed in the process being removed by treatment with dilute hydrochloric acid. The carbonaceous matter liberated was treated with Schultz solution (potassium chlorate and concentrated nitric acid), a period of about two hours at room temperature being found suitable for these Devonian samples. Finally the oxidation products were treated with dilute alkali (sodium hydroxide or potassium carbonate solution). The residue was washed to neutrality at each stage of the process, using a centrifuge for the purpose.

The final maceration residue was mounted on microslides, using a Canada balsam-xyol solution as the mounting medium. Specimens selected for photographing were located with a Carl Zeiss (Oberkochen) microscope by means of their stage co-ordinates expressed to the nearest 0·1 mm. In addition the co-ordinates of an easily located reference point, selected as the lower right-hand corner of the cover glass (inserted with the label to the observer's left) have been determined in each case. This reference point is quoted in the text, along with the co-ordinates of each holotype or figured specimen, so that with this information the specimens can be readily located by means of any microscope equipped with a mechanical stage. All slides are stored in the palynological collection of the Geological Survey of Queensland.

Photographs were taken using a Leitz "Makam" camera attachment. Negatives were made directly on "Kodalith" Panchromatic plates from which contact prints were produced on Velox paper.

SPORE CLASSIFICATION

The spores described have been assigned to genera and species in accordance with accepted taxonomic procedure. As far as supra-generic assignment is concerned, so little is known in detail of the affinities of these Devonian spores that assignment to natural groups cannot be attempted. Accordingly Potonié's morphological classification (as applied by Richardson (1965) and other workers) has been used to provide a systematic arrangement of the genera recorded below. Application of this classification facilitates orderly grouping of the genera. One disadvantage, as far as Devonian genera are concerned, is that spores with bifurcate processes are not all grouped together. This type of ornamentation is so distinctive and so characteristic of Devonian microfloras as to hint at the possibility of a genetic relationship. Such a relationship could be obscured by assigning the spores concerned to different supra-generic categories.

SYSTEMATIC DESCRIPTIONS

Turma	ALETES Ibrahim 1933
Subturma	AZONALETES (Luber 1935) Potonié and Kremp 1954
Infraturma	PSILONAPITI Erdtman 1947
Genus	PILASPORITES Balme and Hennelly 1956

Remarks.—Pilasporites Balme and Hennelly 1956 has chronological priority over *Inapertisporites* (van der Hammen 1955) ex Rouse 1959 for spores of this type. Although *Pilasporites* was proposed when the authors were adherents of the "sporomorph" system of taxonomy (a system which is not entirely in accord with modern taxonomic procedure) Balme subsequently (1957, p. 28) used the name as a generic

designation in conformity with current taxonomic practice. McGregor (1964, p. 3) accepted *Pilasporites* as a valid generic taxon and continuance of this usage seems desirable.

Although *Inaperturopollenites* Thomson and Pflug 1953 has a similar generic diagosis to that of *Pilasporites,* this earlier name has been applied to Mesozoic and Tertiary pollen grains of probable coniferous affinity. Its use to record Devonian spores having probable fungal, algal or bryophytic relationships thus seems quite inappropriate, so that although there is an overlap in the scope of the genera, *Pilasporites* is preferred as a designation for these Devonian spores.

Pilasporites sp.

Plate 1, Figures 1 and 2

Figured specimen (Plate 1, Figure 1).—Slide O.D. 2649, stage co-ordinates 34·8, 94·7; diameter 68 microns. Co-ordinates of lower right-hand corner of cover glass 46·6, 88·5.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8705 ft.

Figured specimen (Plate 1, Figure 1).—Slide O.D. 2626, stage co-ordinates 34·5, 93·9; diameter 36 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·3.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8336 ft. 1 in.

Remarks.—The specimens figured are representative of the spores assigned to this genus, which have smooth to finely scabrate exines, circular or sub-circular outlines (usually folded to some extent) and diameters ranging from about 20 to 100 microns. In the absence of both haptotypic features and distinctive ornamentation, scope for recognition of well defined specific taxa is severely limited. Consequently further differentiation of these specimens has not been attempted.

Distribution.—Etonvale Formation, Buckabie Formation (Adavale Basin).

Turma	TRILETES Reinsch 1891
Subturma	AZONOTRILETES Luber 1935
Infraturma	LAEVIGATI (Bennie and Kidston) Potonié and Kremp 1954
Genus	LEIOTRILETES (Naumova) Potonié and Kremp 1954.

Leiotriletes sp. A

Plate 1, Figure 3.

Description.—Amb triangular with straight or slightly convex inter-radial margins. Diameter (based on 80 measured specimens) 15 to 36 microns. Trilete, distinct laesurae, with slight to distinct development of lips, extend to, or almost to, equator. Exine laevigate or infra-punctate, about 1 micron in thickness.

Figured specimen (Plate 1, Figure 3).—Slide O.D. 2675, stage co-ordinates 38·8, 89·3; diameter 20 microns. Co-ordinates of lower right-hand corner of cover glass 46·9, 81·6.

Locality.—P.S. Gumbardo No. 1 well, Core 10, 9,561 ft. 5 in.

Remarks.—The spores recorded here are distinguished by their size and shape from the larger, more convex specimens observed in the assemblages studied. In the past many species have been assigned to *Leiotriletes* which are difficult to differentiate on the basis of published information. This applies particularly to species recorded in the Russian literature. Consequently detailed comparison has not been attempted; the use of the provisional designation "*Leiotriletes* sp. A" should enable study of the distribution of spores of this type within the Adavale Group.

Another specimen figured (Plate 1, Figure 4) has a very fine ornament, intermediate between that of *Granulatisporites phillipsi,* sp. nov., described below and *Leiotriletes* sp. A. These two species are very similar in overall size and shape of the amb and it is possible that the spores recorded as *Leiotriletes* sp. A may represent corroded specimens of *G. phillipsi.*

Distribution.—Etonvale Formation (Adavale Basin).

Leiotriletes sp.

Remarks.—In the absence of distinctive characters, differentiation of species of *Leiotriletes* is difficult and may be inconclusive. Accordingly, apart from *Leiotriletes* sp. A, recorded above, other specimens of the genus have been recorded as *Leiotriletes* sp.

Genus PUNCTATISPORITES (Ibrahim) Potonié and Kremp 1954

Punctatisporites etonvalensis, sp. nov.

Plate 1, Figures 5 and 6

Diagnosis.—Amb circular or sub-circular. Diameter (based on 9 measured specimens) 68 to 106 microns. Trilete; laesurae straight, extending to, or almost to, equator; inner portions distinct, often opened, bordered by darkened contact areas. Proximal darker portion with sub-triangular outline, diameter about one-third diameter of amb, gradually merging radially into lighter portion of exine. Outer portions of laesurae relatively inconspicuous. Exine laevigate, occasionally folded, thickness about 2 to 4 microns.

Holotype (Plate 1, Figure 5).—Slide O.D. 2282, stage co-ordinates 41·9, 87·8; diameter 72 microns. Co-ordinates of lower right-hand corner of cover glass 45·9, 85·1.

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Figured specimen (Plate 1, Figure 6):—Slide O.D. 2716, stage co-ordinates 33·0, 88·0, diameter 69 microns. Co-ordinates of lower right-hand corner of cover glass 47·6, 80·5.

Locality.—P.S. Gumbardo No. 1 well, Core 12, 10,318 ft.

Remarks.—The proximal darkened area and the extension of the laesurae almost to the periphery of the amb are illustrated by the holotype (Plate 1, Figure 5). In the other figured specimen the laesurae are opened; the darkened peripheral portion in this specimen is apparently an effect of preservation and not a persistent feature of the species.

Punctatisporites etonvalensis differs from typical species of *Punctatisporites,* in having darkened contact areas, with the exception of *P. confossus* Richardson (Richardson 1965, pp. 561, 562). It is distinguished from that species by its smooth, not infrapunctate exine. In both species, the trilete rays are longer and the exine thicker than for typical species of *Calamospora.* (Thus *Calamospora atava* (Naumova) McGregor has appreciably shorter laesurae (rays $\frac{1}{2}$ or $\frac{2}{3}$ spore radius) and a thinner exine). They also differ from the genus *Phyllothecotriletes* Luber which, although similar in having a thick exine and darkened contact areas, is distinguished by its shorter laesurae. This is illustrated by the species *Phyllothecotriletes nigratus* (Naumova), comb. nov., recorded below, which has markedly shorter laesurae and a somewhat thinner exine than *P. etonvalensis.*

Distribution.—Etonvale Formation (Adavale Basin).

Punctatisporites sp.

Plate 3, Figure 1.

Figured specimen (Plate 3, Figure 1).—Slide O.D. 2622, stage co-ordinates 31·3, 99·3; diameter 44 microns. Co-ordinates of lower right-hand corner of cover glass 47·8, 86·2.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—The assemblages include many specimens which, because of their smooth exines, long laesurae and circular or sub-circular ambs, may be assigned to the genus *Punctatisporites.* In the absence of ornamentation, specific classification of such spores is difficult and has not been attempted in the present investigation. The specimens show some variation in size and thickness but with continuous variation neither feature is a reliable criterion. A typical specimen is figured (Plate 3, Figure 1).

Genus PHYLLOTHECOTRILETES Luber 1955

Phyllothecotriletes nigratus (Naumova), comb. nov.

Plate 1, Figures 7 and 8

1953 *Leiotriletes nigratus* Naumova, p. 23, pl. 1, Fig. 9

non 1955 *Trachytriletes nigratus* (Naumova) Kedo, p. 20, pl. 1, fig. 10.

Description (based on Queensland specimens).—Amb circular or sub-circular. Diameter (three specimens) 60 to 66 microns. Trilete, laesurae distinct, straight, approximately one-third spore radius, surrounded by a darkened, well defined contact area. Exine laevigate, about 1 to 2 microns in thickness, folding usually present, colour light to dark brown.

Figured specimen (Plate 1, Figure 7).—Slide O.D. 2709, stage co-ordinates 28·6, 101·9; diameter 60 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 85·4.

Locality.—P.S. Gumbardo No. 1 well, Core 11, 9,896 ft.

Figured specimen (Plate 1, Figure 8).—Slide O.D. 2608, stage co-ordinates 37·4, 94·9; diameter 66 microns. Co-ordinates of lower right-hand corner of cover glass 49·7, 84·1.

Locality.—P.S. Etonvale No. 1 well, Core 17, 8,278 ft. 5 in.

Remarks.—The identification of these Queensland spores with *Leiotriletes nigratus* Naumova is based on their close correspondence to Naumova's descriptions (1953, p. 23) and on the striking similarity of one of them (Plate 1, Figure 8) to Naumova's figure of her holotype (Naumova 1953, pl. 1, fig. 9). Assignment to this species is also supported by Dr. Tschibrickova (Personal communication).

Kedo (1955, p. 20) transferred this species to *Trachytriletes,* on the basis of its ornamented (chagrenate) exine. As McGregor points out (1964, p. 7) it is preferable to regard Kedo's specimens as a distinct species as Naumova specifically stated that the exine is laevigate. The stippling of Naumova's drawings noted by McGregor could equally well indicate a thick, rather than an ornamented exine.

The species is here transferred to *Phyllothecotriletes* Luber as a new combination on the basis of its short laesurae, darkened contact areas and smooth, moderately thick exine, which is more rigid than that of typical species of *Calamospora.* It can be readily distinguished from *Punctatisporites etonvalensis,* sp. nov., among specimens from the Adavale Basin, the laesurae being significantly shorter and the exine somewhat thinner than in that species. *Calamospora atava* (Naumova) McGregor has longer laesurae (half to two-thirds spore radius), a thinner exine and contact areas which are not so sharply defined as in *P. nigratus.*

Distribution.—Middle and Upper Devonian of Russian Platform (Naumova 1953); Etonvale Formation (Adavale Basin).

Genus RETUSOTRILETES Naumova 1953

Remarks.—The recent emendation of this genus by Richardson (1965, p. 563), to include only laevigate spores, is not accepted here. The reason given for this restriction (Richardson 1965, p. 564) is that "it is only in such spores (in the assemblages studied) that the curvaturae perfectae form a constant character". However in other Devonian assemblages, species are known which have both curvaturae perfectae and distinct ornament. An example is *Retusotriletes greggsi* McGregor, which combines both curvaturae perfectae and distinct distal-equatorial ornament (McGregor 1964, p. 8). Several other such species have been recorded from Russian assemblages, e.g. *Retusotriletes subgibberosus* Naumova and *R. apsogus* Tschibrickova.

If the laevigate character alone is taken as the criterion for emendation, difficulty is experienced in the assignment of certain species recorded in the Russian literature. These are species with scabrate (chagrenate) exines, e.g. *R. communis* Naumova, which represent an intermediate condition between laevigate exines and those ornamented by distinctly separate sculptural elements. Consequently it is considered desirable, while retaining a laevigate species (*R. simplex* Naumova) as type species, to allow for variation in exine sculpture. The immediate result of this interpretation of the genus, as far as the Queensland specimens are concerned, is that *R. devonicus* Naumova, a distinctly ornamented species, is retained in *Retusotriletes*.

Retusotriletes simplex Naumova 1953

Plate 2, Figures 1 and 2

Description (based on Queensland specimens).—Amb circular or sub-circular. Diameter (based on 55 measured specimens) 36 to 61 microns. Trilete, laesurae distinct, often with slight thickening of lips, straight or occasionally slightly sinuous, extending to, or almost to, equator. Contact areas large, with distinct curvaturae perfectae which form part of equatorial thickening. Exine laevigate, thickness 2 to 5 microns, with distinct thickening at ends of laesurae; colour light brownish yellow to dark brown.

Figured specimen (Plate 2, Figure 1).—Slide O.D. 2441, stage co-ordinates 39·1, 98·2; diameter 41 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·4.

Locality.—P.S. Gilmore No. 1 well, Core 9, 10,937 ft. 6 in.

Figured specimen (Plate 2, Figure 2).—Slide O.D. 2451, stage co-ordinates 42·9, 96·0; diameter 43 microns. Co-ordinates of lower right-hand corner of cover glass 45·9, 82·6.

Locality.—P.S. Gilmore No. 1 well, Core 9, 10,937 ft. 6 in.

Remarks.—The Queensland specimens agree in all essential features with those described by Naumova (1953, p. 29) and Tschibrickova (1959, p. 49); their size range is somewhat greater, although including specimens in the 30 to 40 micron range, quoted by the latter author. Consequently the Queensland specimens are regarded as extending the size range of Naumova's species. Their identification with *R. simplex* is supported by Dr. Tschibrickova (Personal communication). Specifically they are distinguished from *R. communis* Naumova by the laevigate exine and from *R. pychovii* Naumova by the longer laesurae, the curvaturae forming part of the equatorial thickening instead of being distinct from it as in that species.

Distribution.—Middle and Upper Devonian of U.S.S.R. (Naumova 1953, Tschibrickova 1959); Etonvale Formation (Adavale Basin).

Retusotriletes pychovii Naumova 1953

Plate 2, Figure 3

Description (based on Queensland specimens).—Amb circular or sub-circular. Diameter (three specimens) 46 to 68 microns. Trilete, laesurae straight, distinct lips, about half spore radius. Contact areas clearly defined, depressed, bordered by well defined arcuate curvaturae up to 2 microns wide, joining the other ends of the laesurae. Exine about 2 microns thick at equator, laevigate.

Figured specimen (Plate 2, Figure 3).—Slide O.D. 2625, stage co-ordinates 28·1, 93·9; diameter 46 microns. Co-ordinates of lower right-hand corner of cover glass 46·6, 85·7.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8336 ft. 1 in.

Remarks.—No significant difference can be detected between the Queensland specimens and those described by Naumova (1953, pp. 88, 123). Naumova distinguished two varieties, *R. pychovii* var. *pychovii* and *R. pychovii* var. *major,* on the basis of size distribution. As only three specimens of the species have been observed in the Queensland material, size distribution studies have not been possible. Accordingly, until a similar pattern of size distribution can be demonstrated, identification with the Russian spores, which is supported by Dr. Tschibrickova (Personal communication) is carried no further than the specific level.

The Queensland specimens are also regarded as specifically identifiable with those described as *Retusotriletes* cf. *R. pychovii* from the Gneudna Formation of Western Australia (Balme 1960, p. 4), the similarity of Balme's Plate 1, Figure 3, to Plate 2, Figure 3, of this paper being evident. Spores comparable with the larger variety of the species are also recorded by Balme and Hassell (1962, p. 7) from the Famennian of Western Australia.

Distribution.—Middle and Upper Devonian of Russian Platform (Naumova 1953), ? Lower Devonian of England (Chaloner 1963); Gneudna Formation of Western Australia (Balme 1960); ? Famennian of Western Australia (Balme and Hassell 1962); Etonvale Formation (Adavale Basin).

Retusotriletes tenerimedium Tschibrickova 1959

Plate 2, Figure 4

Description (Queensland specimen).—Amb sub-circular. Diameter (one specimen) 53 microns. Trilete, laesurae distinct, straight or slightly curved, extending to equator. Curvaturae (poorly preserved) evident at ends of laesurae, merge into equatorial thickening. Proximal exine differentially thickened; thinner rounded sub-triangular apical portion (diameter about one-third spore diameter) surrounded by a thicker, darker portion. Exine laevigate; thickness at equator 1·5 microns, colour light brown (central thinner portion) to dark brown (remainder of exine).

Figured specimen (Plate 2, Figure 4).—Slide O.D. 2677, stage co-ordinates 40·6, 93·3; diameter 53 microns. Co-ordinates of lower right-hand corner of cover glass 47·6, 86·4.

Locality.—P.S. Gumbardo No. 1 well, Core 10, 9,561 ft. 5 in.

Remarks.—Although only one definite specimen has been found, it agrees in all essential features with the description of the Russian species by Tschibrickova (1959, p. 52) and shows an evident similarity to her figures (pl. 5, figs. 9, 10). This identification has been confirmed by Dr. Tschibrickova (Personal communication). The species is readily distinguished from other species of *Retusotriletes* by the differential thickening of the proximal exine.

Distribution.—Upper Eifelian and lower Givetian of Bashkiri region, U.S.S.R. (Tschibrickova 1959, 1962); Etonvale Formation (Adavale Basin).

Infraturma APICULATI (Bennie and Kidston) Potonié 1956

Retusotriletes sp. cf. *R. devonicus* Naumova 1953

Plate 2, Figures 5, 6 and 7.

Description (Queensland specimen).—Amb subcircular. Diameter (one specimen) 68 microns. Trilete, laesurae distinct, straight or slightly sinuous, length about two-thirds spore radius. Curvaturae present, with their greatest width (about 2 to 3 microns) adjacent to ends of laesurae, gradually tapering away from laesurae and narrowest in middle part of inter-radial areas. Proximal contact facets depressed, laevigate. Exine (apart from contact facets) finely granulate, with closely packed rounded projections, about 0·5 to 1 micron in basal diameter, less than 1 micron apart. Exine about 1 micron in thickness, colour light brown.

Figured specimen (proximal, equatorial and distal foci—Plate 2, Figures 5, 6 and 7).—Slide O.D. 2676, stage co-ordinates 42·3, 88·7; diameter 68 microns. Co-ordinates of lower right-hand corner of cover glass 47·6, 86·8.

Locality.—P.S. Gumbardo No. 1 well, Core 10, 9,561 ft. 5 in.

Remarks.—The specimen figured is similar in many respects to *R. devonicus* Naumova 1953. It is compared, rather than identified, with that species, because the overall diameter is somewhat less than that quoted by Tschibrickova (1959, p. 50) and also because the granulate projections, while closely packed, are slightly smaller than those illustrated for the Russian species.

Distribution.—Upper Eifelian and Givetian of U.S.S.R. (Tschibrickova 1959, 1962); Etonvale Formation (Adavale Basin).

Genus GRANULATISPORITES (Ibrahim) Potonié and Kremp 1954

Granulatisporites phillipsi, sp. nov.

Plate 2, Figures 8, 9 and 10

Diagnosis.—Amb triangular, sides straight or slightly convex. Diameter (based on 51 measured specimens) 15 to 36 microns, majority of specimens 20 to 30 microns. Trilete, laesurae normally straight, distinct to inconspicuous, extending to equator without any significant development of lips. Distal exine ornamented with rounded sub-hemispherical or slightly conical projections, 0·5 to 1 micron in basal diameter, about 1 micron apart, uniformly distributed. Proximal sculpture reduced; projections 0·5 micron or less in diameter, about 1 micron apart, uniformly distributed. Exine 1 micron or less in thickness.

Holotype (Plate 2, Figure 8).—Slide O.D. 2469, stage co-ordinates 42·9, 102·5; diameter 23 microns. Co-ordinates of lower right-hand corner of cover glass 47·3, 88·0.

Locality.—P.S. Etonvale No. 1 well, Core 24, 10,007 ft.

Figured specimen (Plate 2, Figure 9).—Slide O.D. 2469, stage co-ordinates 35·6, 95·0; diameter 20 microns. Co-ordinates of lower right-hand corner of cover glass 47·3, 88·0.

Locality.—P.S. Etonvale No. 1 well, Core 24, 10,007 ft.

Figured specimen (Plate 2, Figure 10).—Slide O.D. 2456, stage co-ordinates 31·8, 92·5; diameter 20 microns. Co-ordinates of lower right-hand corner of cover glass 46·8, 85·2.

Locality.—P.S. Etonvale No. 1 well, Core 24, 10,007 ft.

Remarks.—Plate 2, Figures 8 and 9 show the distal sculpture of this species. The characteristic reduction in size of the proximal sculptural elements is illustrated by Figure 10, which is of a laterally compressed specimen, with the proximal face on the right-hand side and the distal ornament on the left-hand side.

On the basis of published descriptions, this species is most closely comparable with the Carboniferous *Granulatisporites granulatus* Ibrahim (Ibrahim 1933, p. 22) and the Devonian *Anapiculatisporites apiculatus* Guennel (Guennel 1963, pp. 250, 251). The former differs in not having reduced proximal sculptural elements, while the latter has a smooth proximal face and shorter laesurae than the Queensland species. The specific name is given in recognition of the assistance of the Phillips Petroleum Company; the majority of the cores sampled came from wells drilled by this company.

Distribution.—Etonvale Formation (Adavale Basin).

Genus CYCLOGRANISPORITES Potonié and Kremp 1954

Cyclogranisporites sp.

Plate 3, Figure 2.

Description (based on Queensland specimens).—Amb circular or sub-circular. Diameter (based on 149 measured specimens) 31 to 63 microns. Trilete, laesurae distinct, inconspicuous or imperceptible, where evident extending to, or almost to, equator, without significant development of lips. Exine, ornamented on both surfaces with small, closely packed, rounded to conical projections. Basal diameter of projections about 0·5 to 1 micron, 0·5 to 1 micron apart. Exine of medium thickness, colour light yellow or light brown.

Figured specimen (Plate 3, Figure 2).—Slide O.D. 2558, stage co-ordinates 34·4, 42·6; diameter 43 microns. Co-ordinates of lower right-hand corner of cover glass 47·4, 82·4.

Locality.—P.S. Etonvale No. 1 Well, Core 20, 8,767 ft.

Remarks.—Spores of this type are common in most of the assemblages. The fine sculptural elements are near the limit of resolution with an oil immersion objective; as Chaloner points out (1963, p. 107), "separation of *Planisporites* and *Cyclogranisporites,* made on the basis of conical versus rounded or blunt sculptural elements respectively, becomes rather arbitrary in cases such as this".

Comparable Devonian species are *Lophotriletes rotundus* Naumova (Naumova 1953, p. 58) and *L. subrotundatus* Naumova (Naumova 1953, p. 27). The latter, with its longer laesurae, appears closest to the Queensland specimens. However, specific assignment has not been attempted for the spores recorded here, because of the difficulty in interpreting the nature of the fine sculptural elements from Naumova's line drawings and brief descriptions, and also because of the fairly wide range of variation shown by the specimens examined.

Distribution.—Etonvale Formation, Buckabie Formation (Adavale Basin).

Genus SCHOPFITES (Kosanke 1950), Emend.

The generic diagnosis of *Schopfites* Kosanke 1950 is here emended to the following:—

Spores radial trilete; amb circular or sub-circular. Trilete, laesurae straight, distinct or inconspicuous. Entire or greater portion of proximal exine laevigate. Distal exine and (in some specimens) equatorial portion of proximal exine, ornamented by closely packed to imbricating, verrucae or coni. Projections rounded to suboval in basal outline.

Type Species.—Schopfites dimorphus Kosanke (Kosanke 1950, pp. 52, 53.)

Remarks.—The emendation proposed here retains the essential diagnostic characters emphasised by Kosanke (1950, p. 52), namely the laevigate or mainly laevigate proximal exine and the characteristic mass of distal verrucae. At the same time removal of the restriction on overall size and on the size of the projections increases the utility of the taxon for designating species such as *Schopfites microverrucatus,* sp. nov., described below, which, like the genotype, are characterised by a similar dimorphic type of spore coat.

Schopfites microverrucatus, sp. nov.

Plate 3, Figures 3, 6 and 8

Diagnosis.—Amb circular or sub-circular. Diameter (based on 22 measured specimens) 38 to 64 microns. Trilete mark distinct to inconspicuous, laesurae straight, extending to, or almost to, equator. Proximal exine and equatorial region of distal exine (width about 2 to 3 microns) laevigate. Remainder of distal exine ornamented by low verrucae (height about 1 micron), basal diameter 1·5 to 3 microns. Basal outline of projections mostly sub-circular or sub-oval. Projections closely packed (1 micron of less apart); predominantly discrete, some imbricating or confluent; when confluent forming short rounded ridge-like structures. Exine about 2 microns in thickness.

Holotype (Distal focus—Plate 3, Figure 8).—Slide O.D. 2677, stage co-ordinates 33·1, 101·8; diameter 54 microns. Co-ordinates of lower right-hand corner of cover glass 47·6, 86·4.

Locality.—P.S. Gumbardo No. 1 well, Core 10, 9,561 ft. 5 in.

Figured specimen (Distal focus—Plate 3, Figure 3).—Slide O.D. 2674, stage co-ordinates 37·8, 101·9; diameter 38 microns. Co-ordinates of lower right-hand corner of cover glass 48·4, 86·3.

Locality.—P.S. Gumbardo No. 1 well, Core 10, 9,561 ft. 5 in.

Figured specimen (Distal focus—Plate 3, Figure 6).—Slide O.D. 2541, stage co-ordinates 43·3, 100·2; diameter 48 microns. Co-ordinates of lower right-hand corner of cover glass 47·5, 86·7.

Locality.—P.S. Etonvale No. 1 well, Core 21, 9,095 ft. 4 in.

Remarks.—The specific name has reference to the fine verrucate ornamentation; the sculptural elements are smaller in size than those of *Schopfites dimorphus* Kosanke and *S. colchesterensis* Kosanke. The Queensland spores also differ from these Carboniferous species in being appreciably smaller and in having the mass of verrucae confined to the distal surface, leaving a smooth band of exine in the distal equatorial region. The projections are also more uniform in size than in Kosanke's species. A species described from the Lower Carboniferous, *S. augustus* Playford, also has larger, more diverse, sculptural elements. *S. saarensis* Bhardwaj, from the Upper Carboniferous, although ornamented with coni about the same size as the verrucae of the Queensland specimens, differs in that the sculpture extends irregularly on to the proximal surface.

Among Devonian species the distal ornamentation is most closely comparable with that of *Lophotriletes fastuosus* Naumova (Naumova 1953, p. 27). However drawings of that species show the verrucae projecting at the equator, indicating that the sculpture is not confined to the distal surface as in the Queensland spores.

In having a smooth proximal exine the species is clearly distinct from species of *Verrucosisporites* recorded by Smith *et al.* (1964, p. 1071) and is excluded by this feature from the circumscription of that genus advocated by those authors. For this reason it has been placed in *Schopfites,* as emended above, rather than in *Verrucosisporites.* Assignment of this species to *Schopfites* extends the range of the genus, previously recorded from the Upper Carboniferous (Kosanke 1950, Bhardwaj 1957) and Lower Carboniferous (Playford 1963b) back to the Middle Devonian.

Distribution.—Etonvale Formation (Adavale Basin)

Genus HETEROTRILETES, Gen. nov.

Generic diagnosis.—Amb sub-circular or roundly triangular, outline normally broken by sculptural elements at equator. Spores trilete, laesurae distinct except where obscured by ornamentation. Distal exine and equatorial regions ornamented by verrucate, rugulate or bluntly spinose projections which show marked variation in size within individual specimens. Projections attain their greatest size in equatorial region, where a small number of relatively large verrucae or rugulae are developed. Projections discrete to confluent but not forming a closely packed, anastomosing pattern. Remainder of proximal exine laevigate.

Type Species.—Heterotriletes priscus, sp. nov. described below.

Remarks.—Richardson (1965, p. 572) in describing *Verrucosisporites premnus,* from the Devonian of Scotland, points out that "the presence of large and small sculptural elements on individual specimens of this species is a feature which may eventually warrant generic recognition". The need for according such spores separate generic status has been further emphasised by the discovery of Queensland specimens showing marked variation in the size of the sculptural elements, described below as *Heterotriletes priscus,* sp. nov. Spores of this type are distinguished from *Verrucosisporites,* as recently defined by Smith *et al.* (1964, p. 1071) by the marked variation in the size of the sculptural elements and by their being largely confined to the distal and equatorial regions. Like *Verrucosisporites,* they differ from both *Camptotriletes* and *Convolutispora* in "possessing ornamentation of more or less discrete elements which may sometimes be confluent at their bases but never anastomose to form a system of open or loosely packed ridges". Another genus, *Pustulatisporites,* resembles *Heterotriletes* in having widely spaced sculptural elements, but lacks the development of larger projections in the equatorial region which characterises the latter.

The generic name has reference to the trilete character and to the heterogeneous nature of the sculptural elements, which vary so markedly in size in individual specimens.

Heterotriletes priscus, sp. nov.

Plate 3, Figures 4, 5 and 7.

Diagnosis.—Amb circular or sub-circular, outline slightly uneven due to extension of projections in equatorial region. Diameter (based on 18 measured specimens) 35 to 63 microns. Trilete mark distinct (without development of lips) to ill defined or obscured by ornamentation. Distal and equatorial portions of exine ornamented by verrucate to rugulate sculptural elements, which are rounded to elongate in basal section, of average width 6 microns, height 1 to 3 microns, and show marked size variation within individual specimens. Sculptural elements discrete to confluent; where confluent, not forming a pattern of anastomosing ridges; also show a tendency to increase progressively in size from polar to distal equatorial region, where one or more ridge-like elements, of uneven width, occur. Remainder of proximal exine laevigate. Exine (apart from projections) about 1 or 2 microns in thickness.

Holotype (Median focus—Plate 3, Figure 4).—Slide O.D. 2648, stage co-ordinates 40·7, 100·5; diameter 49 microns. Co-ordinates of lower right-hand corner of cover glass 47·9, 85·6.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Figured specimen (Median focus—Plate 3, Figure 5).—Slide O.D. 2648, stage co-ordinates 41·9, 100·0; diameter 53 microns. Co-ordinates of lower right-hand corner of cover glass 47·9, 85·6.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Figured specimen (Median focus—Plate 3, Figure 7).—Slide O.D. 2647, stage co-ordinates 29·6, 98·3; diameter 52 microns. Co-ordinates of lower right-hand corner of cover glass 46·6, 88·5.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—The three specimens figured illustrate the range of variation in the species. Plate 3, Figure 5 is representative of specimens with a development of heavy equatorial ridges in addition to the distal verrucae; Plate 3, Figure 7 shows the other extreme of a few smaller distal verrucae and one equatorial ridge; the holotype represents an intermediate condition. The Queensland spores are distinguished from *Verrucosisporites premnus* Richardson (Richardson 1965, p. 572) by having much lower verrucae (particularly the larger projections), by being smaller in size and in having less prominent laesurae. *Verrucosisporites variabilis* McGregor 1960 (McGregor 1960, p. 30) differs in having some sharply spinose projections in addition to the more rounded verrucae.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Genus APICULATISPORIS (Ibrahim) Potonié and Kremp 1956

Apiculatisporis adavalensis, sp. nov.

Plate 3, Figures 9 and 10; Plate 4, Figures 1 and 2

Diagnosis.—Amb rounded sub-triangular to sub-circular, frequently distorted by folding. Diameter (based on 134 measured specimens) 41 to 81 microns. Trilete mark inconspicuous or indeterminate, where evident laesurae may be indicated by adjacent folds, but are without any marked development of lips. Exine ornamented by closely packed projections, consisting dominantly of coni with basal diameter and height about equal and approximately 1 micron; coni showing a gradation to rounded granulate elements and also to narrower sub-baculate projections about 2 microns in length. Gradation in sculpture evident both within individual specimens and from one specimen to another. Exine relatively thin (1 micron or less).

Holotype (Plate 4, Figure 1).—Slide O.D. 2626, stage co-ordinates 38·0, 93·9; diameter 69 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·3.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured Specimen (Plate 3, Figure 9).—Slide O.D. 2621, stage co-ordinates 33·8, 99·6; diameter 54 microns. Co-ordinates of lower right-hand corner of cover glass 47·3, 87·8.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Plate 3, Figure 10).—Slide O.D. 2626, stage co-ordinates 37·9, 100·8; diameter 73 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·3.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Plate 4, Figure 2).—Slide O.D. 2623, stage co-ordinates 38·4, 97·1; diameter 54 microns. Co-ordinates of lower right-hand corner of cover glass 48·3, 86·4.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,116 ft. 1 in.

Remarks.—Of the specimens figured, the holotype illustrates a spore with folds adjacent to the laesurae; weak laesurae are visible in another specimen (Plate 4, Figure 2). The gradation to larger projections is illustrated in Plate 3, Figure 10.

Apiculatisporis adavalensis is distinguished from other species of the genus by its inconspicuous or indeterminate laesurae (not observed in many specimens). The thin, frequently folded exine and dense apiculate sculpture are other diagnostic features. Thus *A. microconus* Richardson (Richardson 1965, p. 566) differs in having well defined laesurae and contact areas; *A. elegans* McGregor (McGregor 1960, p. 30) has more distinct laesurae and an exine which, although thin, is rarely folded. The specific name refers to the occurrence of the species in the Devonian sediments of the Adavale Basin.

Distribution.—Etonvale Formation (Adavale Basin).

Genus DIBOLISPORITES Richardson 1965

Dibolisporites sp.

Plate 4, Figures 3, 4, 5, 8 and 9

Figured specimen (Proximal, distal foci—Plate 4, Figures 3 and 4).—Slide O.D. 2606, stage co-ordinates 29·3, 89·1; diameter 74 microns. Co-ordinates of lower right-hand corner of cover glass 47·5, 87·9. (Plate 4, Figures 5 and 8 illustrate two biform projections from this specimen at higher magnification).

Locality.—P.S. Etonvale No. 1 well, Core 17, 8,278 ft. 5 in.

Figured specimen (Plate 4, Figure 9).—Slide O.D. 2280, stage co-ordinates 29·8, 95·9; diameter 89 microns. Co-ordinates of lower right-hand corner of cover glass 46·8, 84·3.

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Remarks.—The two specimens figured indicate the presence of this genus, recently established by Richardson (1965, p. 568) in the Devonian of Queensland. The better preserved specimen has the typical biform projections of the genus (Plate 4, Figures 5 and 8). In thickness of exine, size and shape of the projections it is comparable with *Dibolisporites correctus* (Naumova) Richardson (Richardson 1965, pp. 568, 569) but differs from specimens described by that author in having more sparsely distributed projections and a more prominent trilete mark. The other specimen (Plate 4, Figure 9) is more closely comparable with *D. correctus,* particularly the specimens described by Richardson, in having closely-packed, broad based projections, but in view of its poor preservation no formal specific identification or comparison has been made.

Distribution.—Etonvale Formation (Adavale Basin).

Genus HYSTRICOSPORITES McGregor 1960

Hystricosporites richardsoni, sp. nov.

Plate 5, Figures 1, 2, 6 and 7

Diagnosis.—Equatorial outline sub-circular; in lateral view sub-circular with flattened apex bearing a distinct apical prominence. Equatorial diameter (excluding spines) 68 to 150 microns (based on 25 measured specimens); polar diameter (excluding apical prominence) and equatorial diameter approximately equal. Trilete; triradiate mark with elevated membranous ridges (about 20 to 30 microns high in lateral view) forming the apical prominence. Exine ornamented in distal and equatorial regions by large spines (length 15 to 40 microns). Spines with bifurcate apices and distinctly tapering stems; diameter near apex about 3 microns; bases markedly and abruptly expanded, basal diameter about 10 to 15 microns. Spines fairly uniformly distributed, about 20 to 30 around equator. Exine (between spines) and exine of apical prominence, smooth to distinctly scabrate. Exine (excluding spines and apical prominence) relatively thick, dark brown to opaque.

Holotype (Plate 5, Figure 1).—Slide O.D. 2562, stage co-ordinates 42·6, 87·0; diameter (excluding spines) 126 microns. Co-ordinates of lower right-hand corner of cover glass 47·4, 83·5. (Plate 5, Figure 6 illustrates three spines from this specimen at higher magnification.)

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Figured specimen (Plate 5, Figure 2).—Slide O.D. 976, stage co-ordinates 38·0, 99·2; diameter (excluding spines) 99 microns. Co-ordinates of lower right-hand corner of cover glass 45·6, 85·3.

Locality.—P.S. Etonvale No. 1 well, Core 21, 9,095 ft. 4 in.

Figured specimen (Plate 5, Figure 7).—Slide O.D. 2562, stage co-ordinates 31·6, 92·9. Co-ordinates of lower right-hand corner of cover glass 47·4, 83·5. (Illustrates one spine at higher magnification.)

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Remarks.—The majority of the specimens are preserved in lateral view; the apical prominence, owing to its relative delicacy, is well preserved only in a small proportion of them. Specimens showing the apical prominence are illustrated in Plate 5, Figures 1 and 2. In poorly preserved specimens, the spines are frequently broken; in such cases, the proportion of bifid spines cannot be determined, but in better preserved examples the majority exhibit bifurcate apices. Spines showing the bifurcate apices are figured at higher magnification (Plate 5, Figures 6 and 7). Plate 5, Figure 6 also illustrates the marked basal expansion of the spines, which is also shown in Plate 5, Figure 2.

These spores differ from the genotype, *Hystricosporites delectabilis* McGregor, in having a well developed apical prominence. This feature is also exhibited by *H. corystus* Richardson but the latter species differs in being appreciably larger, in having larger, more widely spaced, spines which lack the distinctly expanded bases observed in the Queensland species. *Archaeotriletes porrectus* Balme and Hassell (1962, p. 10) is of comparable size, but its spines are more numerous and cylindrical or slightly tapering, without any marked basal expansion. Spores recorded below as *Hystricosporites* sp.A lack an apical prominence and have shorter spines which are relative wider in proportion to their length.

The species is named after Dr. J. B. Richardson, in recognition of his research on Devonian spores with bifurcate processes (Richardson 1960, 1962).

Distribution.—Etonvale Formation (Adavale Basin).

Hystricosporites sp. A

Plate 5, Figures 3, 4, 5 and 8

Description.—Amb sub-circular. Diameter (excluding spines) 92, 99 microns (two specimens). Trilete, laesurae, without marked development of lips or apical prominence, about two thirds spore radius. Exine ornamented in distal and equatorial regions by spines with bifurcate apices. Spines about 15 to 20 microns in length; width near extremities about 2 microns, expanding to bulbous bases about 8 to 10 microns in diameter; about 15 in number around equator. Exine (between spines) scabrate, dark in colour.

Figured specimen (Plate 5, Figure 5).—Slide O.D. 2647, stage co-ordinates 32·8, 98·0; diameter 92 microns. Co-odinates of lower right-hand corner of cover glass 47·5, 83·8. (Plate 5, Figures 4 and 8 illustrate two spines from this specimen at higher magnification.)

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Figured specimen (Plate 5, Figure 3).—Slide O.D. 2648, stage co-ordinates 29·5, 99·7. Co-ordinates of lower right-hand corner of cover glass 47·9, 85·6. (Illustrates one spine at high magnification).

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—These spores differ from *Hystricosporites richardsoni,* sp. nov., described above, in having no marked development of an apical prominence and in the spines being shorter, with more bulbous bases and less numerous. They are also distinct from other described species of *Hystricosporites,* but as only two specimens have been observed, proposal of a new specific name must await study of further material.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Genus VERRUCOSISPORITES (Ibrahim) Smith, Butterworth, Knox and Love 1964.

Verrucosisporites pulvinatus, sp. nov.

Plate 5, Figures 9, 10 and 11.

Diagnosis.—Amb sub-circular. Diameter (based on 10 measured specimens) 38 to 59 microns. Trilete, laesurae usually distinct (obscured by distal ornament in some specimens), where evident straight, without marked development of lips, length about three-quarters spore radius. Distal ornament consisting of sub-circular or sub-oval verrucae, average diameter 5 microns, height about 1 or 2 microns, 1 micron or less apart. Some of distal verrucae discrete; remainder fused in groups of two or three (rarely more) to form short, low ridge-like structures. In some specimens verrucae are partially fused in the distal equatorial region which consequently appears darker and thicker (forming a "pseudo-cingulum"). Proximal exine with flattened sub-hemispherical processes at ends of laesurae, length (transverse to laesurae) about 12 microns, width about 6 microns. Remainder of proximal exine thin, laevigate or finely wrinkled. Distal exine moderately thick, dark in colour.

Holotype (Proximal, distal foci—Plate 5, Figures 9 and 10).—Slide O.D. 2524, stage co-ordinates 36·8, 87·3; diameter 48 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 86·5.

Locality.—P.S. Etonvale No. 1 well, Core 22, 9,333 ft. 4 in.

Figured specimen (Distal focus—Plate 5, Figure 11).—Slide O.D. 2569, stage co-ordinates 35·2, 105·5; diameter 48 microns. Co-ordinates of lower right-hand corner of cover glass 47·3, 86·7.

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Remarks.—The specific name (Latin *pulvinus* = a cushion) refers to the cushion-shaped proximal thickenings, which are evident in all cases where the proximal exine is well preserved (Plate 2, Figure 9). This figure of the holotype also shows fine wrinkling of the thin proximal exine, simulating fine verrucate ornament; in all other specimens observed the proximal exine is entirely laevigate. The distal sculpture is illustrated by Figures 10 and 11; the latter shows that the equatorial fusion of the sculptural elements (forming a "pseudo-cingulum"), as in Figure 10, is not a persistent specific character.

The species is here assigned to *Verrucosisporites,* although it is not a typical representative of that genus as now defined. Features in which it differs from typical species of *Verrucosisporites* as recorded by Smith *et al.* (1964, pp. 1071-1077) are in the restriction of the verrucae to the distal surface, the presence of proximal thickenings at the ends of the laesurae and in the frequent fusion of the distal verrucae. However there is a clear distinction from *Camptotriletes* Naumova and *Convolutispora* Hoffmeister, Staplin and Malloy "in possessing ornamentation of more or less discrete elements which may sometimes be confluent at their bases but never anastomose to form a system of open or closely packed ridges" (Smith *et al.* 1964, p. 1071). In addition the species lacks the reticulate arrangement of muri which characterises *Dictyotriletes* (Naumova) Potonié and Kremp.

Zinjisporites Hart (Hart 1965, p. 15) shows some resemblance in the fusion of the equatorial elements to form a "pseudo-cingulum", but this is not a persistent feature of the Queensland species, which also lacks the basal coalescence of the sculptural elements, characteristic of Hart's genus. Likewise *Secarisporites* Neves (Neves 1961, p. 260) also has a "pseudo-cingulum" but this differs from the structure sometimes present in the Queensland spores, in not being continuous and in having deep indentations between the bulbous outgrowths of which it is composed. Another genus, *Pulvinispora* Balme and Hassall, from the Famennian of Western Australia (Balme and Hassell 1962, p. 10) has residual auriculae similar to the proximal thickenings of *V. pulvinatus,* but is without the distinctive distal ornament of that species. The conclusion is thus evident that placing the species in *Verrucosisporites,* although not entirely satisfactory, is more appropriate than assignment to the other genera mentioned.

Distribution.—Etonvale Formation (Adavale Basin).

Infraturma MURORNATI Potonié and Kremp 1954

Genus BROCHOTRILETES Naumova 1953

Remarks.—Naumova (1953, p. 58) described the type species *Brochotriletes foveolatus,* from the Upper Famennian of the Russian Platform. The genus is characterised by a trilete exine ornamented by circular pits. *Perforosporites* Scott and Rouse 1961, from the Lower Devonian of Canada (Scott and Rouse 1961, p. 977) is evidently a synonym of *Brochotriletes* as suggested to the writer by Dr. D. C. McGregor (Personal communication). Placing it in synonymy with Naumova's genus thus extends the generic range down from Upper to Lower Devonian. It is not clear whether *P. robustus* Scott and Rouse is a specific synonym of *B. foveolatus* Naumova; Naumova's brief description of the Russian species prevents detailed comparison.

The Queensland specimens recorded below under *Brochotriletes* sp. can be distinguished from both *B. foveolatus* and *P. robustus* in having smaller pits and thinner exines. In addition other specimens have been observed which apparently show a closer resemblance to *P. robustus.* However further examination of these latter specimens indicates that the openings in the spore wall may be the result of damage to the exine, as a result of its being in contact with inorganic crystals.

Brochotriletes sp.

Plate 6, Figure 1

Description.—Amb circular or sub-circular. Diameter (two specimens) 40, 43 microns. Exine trilete, laesurae inconspicuous or imperceptible; where evident extending almost to equator without marked development of lips. Proximal exine smooth, distal exine ornamented with circular or sub-circular depressions, diameter about 1·5 to 2 microns, depth 1 micron or less, about 2 microns apart. Exine about 1·5 to 2 microns in thickness, colour light brownish yellow to light brown.

Figured specimen (Plate 6, Figure 1).—Slide O.D. 2444, stage co-ordinates 33·9, 85·2; diameter 40 microns. Co-ordinates of lower right-hand corner of cover glass 48·0, 83·0.

Locality.—P.S. Gilmore No. 1 well, Core 9, 10,937 ft. 6 in.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Genus CHOMOTRILETES Naumova ex Naumova 1953

Remarks.—Naumova (1953, p. 58) established this genus for the species *Chomotriletes vedugensis* from the Frasnian of the Russian Platform. Subsequently Luber (1955, p. 65) assigned to it the Carboniferous species C. *alutaceus.* Potonié (1957, p. 22), although he did not formally emend the genus, provided a more comprehensive generic diagnosis and indicated *C. vedugensis* as the type species. Balme (1960, p. 6) recorded *C. vedugensis* from the Devonian of Western Australia and indicated its possible stratigraphic significance.

Spores with concentric striations are also present in the Triassic of the Ipswich Coal Measures (south-eastern Queensland). In proposing the genus *Circulisporites* for these specimens the writer (de Jersey 1962, p. 15) distinguished them from *Chomotriletes* on the basis of their continuous striations and lack of any trilete mark. This distinction was based on Potonié's diagnosis of *Chomotriletes* in which he emphasised the incomplete, interrupted nature of the concentric striations or ridges and also allowed for the occurrence of a weak trilete mark. The former character is evident from Naumova's figure (1953, p. 21). Accordingly, these Triassic specimens are regarded as generically distinct from *Chomotriletes.*

Chomotriletes sp.

Plate 6, Figure 2.

Description.—Outline circular or sub-circular, modified by folding. Diameter (based on 4 measured specimens) 33 to 56 microns. Exine single-layered, ornamented on each surface by a series of low, discontinuous concentric ridges, about 1 micron in width, and about 1 to 2 microns apart. Exine relatively thin, pale yellow or light yellow.

Figured specimen (Plate 6, Figure 2).—Slide O.D. 2626, stage co-ordinates 37·0, 94·3; diameter 56 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·3.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—These spores are distinguished from *Chomotriletes vedugensis* Naumova by their narrower ridges and thinner exines. In these features, together with their size distribution, they also differ from *C. alutaceus* Luber and the two Mesozoic species described by Pocock (1962, pp. 38, 39)

Distribution.—Upper Etonvale Formation and lower Buckabie Formation (Adavale Basin).

Genus Dictyotriletes (Naumova) Potonié and Kremp 1954.

Dictyotriletes australis, sp. nov.

Plate 5, Figures 12, 13, 14, and 15.

Diagnosis.—Amb rounded sub-triangular to sub-circular. Diameter (based on 13 measured specimens) 20 to 40 microns. Trilete; laesurae distinct to imperceptible, where evident extending about half spore radius, with lips thickened for a width of 1 or 2 microns. Proximal exine smooth, distal exine with reticulate sculpture. Reticulum perfect to imperfect, lumina polygonal, diameter 2 to 6 microns. Variation in diameter of lumina evident both within each specimen and between specimens. Muri about 1 micron wide, 1 to 1·5 microns high. Exine about 1·5 microns in thickness.

Holotype (Proximal, distal foci—Plate 5, Figures 12 and 13).—Slide O.D. 2524, stage co-ordinates 32·6, 92·1; diameter 31 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 86·5.

Locality.—P.S. Etonvale No. 1 well, Core 22, 9,333 ft. 4 in.

Figured specimen (Distal focus—Plate 5, Figure 14).—Slide O.D. 2463, stage co-ordinates 30·9, 100·1; diameter 28 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 87·3.

Locality.—P.S. Etonvale No. 1 well, Core 24, 10,007 ft.

Figured specimen (Distal focus—Plate 5, Figure 15).—Slide O.D. 2535, stage co-ordinates 31·0, 101·0; diameter 39 microns. Co-ordinates of lower right-hand corner of cover glass 47·5, 87·4.

Locality.—P.S. Etonvale No. 1 well, Core 22, 9,333 ft. 4 in.

Remarks.—Of the five Devonian species described by Naumova (1953), *Dictyotriletes devonicus* and *D. varius* have much larger lumina than this Queensland species; *D. nigratus and D. famenensis* have much broader muri, while *D. minor,* somewhat comparable in other respects, has appreciably higher muri. Probably the most closely comparable species is *Retusotriletes dictyus* Tschibrickova (Tschibrickova 1962, p. 407. This Eifelian species resembles the Queensland specimens in overall size, size of the lumina and in the presence of thickened lips, but differs in having curvaturae imperfectae, which have not been observed in *D. australis.*

Distribution.—Etonvale Formation (Adavale Basin).

Genus Emphanisporites McGregor 1961

Emphanisporites sp.

Plate 6, Figure 3.

Description.—Amb sub-circular. Diameter (one specimen) 26 microns. Exine trilete; laesurae extend to equator without any development of lips. Proximal face ornamented with radial bands of thickening extending from polar region to equator. Radial bands gradually widening towards equator, where they attain a width of about 2 microns; about 4 bands in each inter-radial area. Exine about 2 microns thick at equator, colour light yellow or brownish yellow. Distal exine laevigate, relatively thin.

Figured specimen (Plate 6, Figure 3).—Slide O.D. 2625, stage co-ordinates 31·4, 88·2; diameter 26 microns. Co-ordinates of lower right-hand corner of cover glass 46·6, 85·7.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—The specimen figured is the only one observed in examination of the samples listed which can be assigned to this distinctive Devonian genus. The radial bands of thickening are present on the proximal face, being in focus at the same level as the laesurae; the distal exine in the specimen is thin and partly torn out. This spore is most closely comparable with *Emphanisporites rotatus* McGregor (McGregor 1961, p. 3), but is appreciably below the size range of that species (33 to 60 microns in diameter). Balme

(1960, p. 6) recorded specimens from the Devonian of Western Australia as "*Radiaspora sp. A*", the informal name *Radiaspora* being used because of uncertainty as to the proximal or distal location of the radial ribs. If the former interpretation is correct, as Balme believes (Personal communication) these specimens are close to *E. rotatus*. Like that species they are significantly larger than the Queensland specimen.

Turma	ZONALES (Bennie and Kidston) R. Potonié, 1956
Subturma	ZONOTRILETES Waltz 1936
Infraturma	CINGULATI Potonié and Klaus 1954
Genus	DENSOSPORITES (Berry) Butterworth, Jansonius, Smith and Staplin 1964.

Densosporites atavus, sp. nov.

Plate 6, Figures 4, 5, 6 and 7.

Diagnosis.—Amb triangular, rounded sub-triangular or sub-circular. Diameter (based on 185 measured specimens) 20 to 46 microns. Trilete mark usually imperceptible, where evident relatively inconspicuous. Intexine laevigate, very thin, poorly preserved or absent. Cingulum dense, rigid, dark in colour, relatively uniform in thickness, width 3 to 9 microns, of uniform width or slightly narrower in radial regions. Proximal exoexine laevigate, distal surface ornamented with grana or coni, about 1·5 microns in diameter, and closely packed (about 1 micron apart) in central area. Sculptural elements more sparsely distributed, or in some cases, completely lacking, on distal surface of cingulum.

Holotype (Plate 6, Figure 6—exposed for ornament on cingulum; Figure 5 exposed for central area).—Slide O.D. 2651, stage co-ordinates 37·7, 98·1; diameter 43 microns. Co-ordinates of lower right-hand corner of cover glass 45·0, 87·8.

Locality.—P.S. Gumbardo No. 1 Well, Core 6, 8,705 ft.

Figured specimen (Plate 6, Figure 4).—Slide O.D. 2647, stage co-ordinates 33·9, 97·9; diameter 33 microns. Co-ordinates of lower right-hand corner of cover glass 47·5, 83·8.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Figured specimen (Plate 6, Figure 7).—Slide O.D. 2646, stage co-ordinates 29·7, 97·5; diameter 35 microns. Co-ordinates of lower right-hand corner of cover glass 47·8, 83·9.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—*Densosporites atavus* differs from *D. devonicus* Richardson from the Middle Devonian (Richardson 1960, p. 57) in being much smaller, in lacking both a well defined trilete mark and a differentially thickened cingulum and in having smaller sculptural elements. *D. crassus* McGregor from the Upper Devonian (McGregor 1960, p. 36) also differs in being appreciably larger, in having a wider cingulum and relatively fine ornamentation.

No close comparison can be made with any species of *Denosporites* described from the Carboniferous, the small size, relatively narrow cingulum, indefinite trilete mark and distinctive ornamentation being features which distinguish these Queensland spores from Carboniferous species recorded in the available literature. The specific name (Latin *atavus* = ancestor) refers to the antiquity of the species; by virtue of its occurrence in Middle Devonian sediments, it is one of the earliest known species of *Densosporites*.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Genus ARCHAEOZONOTRILETES (Naumova) Potonié 1958

Archaeozonotriletes variabilis Naumova 1953

Plate 6, Figures 8 and 9

Description (based on Queensland specimens).—Amb rounded sub-triangular to sub-circular, equatorial outline slightly lobate. Diameter (2 specimens) 43 to 54 microns. Laesurae distinct, straight, simple (without development of lips) extending almost to junction of central area and cingulum. Cingulum laevigate, dark brown, dense, rigid, of variable width (3 to 11 microns). Central area rounded sub-triangular to sub-circular, outline not conformable with amb, distal exine laevigate, proximal exine (of central area) smooth or faintly scabrate, colour brown or brownish yellow.

Figured specimen (Plate 6, Figure 8).—Slide O.D. 2623, stage co-ordinates 46·3, 97·2; dimensions 53 x 43 microns. Co-ordinates of lower right-hand corner of cover glass 48·3, 86·4.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Plate 6, Figure 9).—Slide O.D. 2627, stage co-ordinates 40·4, 97·3; diameter 54 microns. Co-ordinates of lower right-hand corner of cover glass 47·4, 85·7.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—Although only two specimens have been observed, their features are in such close conformity with those of *Archaeozonotriletes variabilis* Naumova (Naumova 1953, pp. 30, 80, 83) that they are identified with that species.

Regarding the occurrence of this species, Dr. Tschibrickova (Personal communication) has pointed out that while it is most typical of the Upper Devonian, forms with a narrow cingulum (similar to the Queensland specimens) also occur in the Middle Devonian. Although Naumova's description allows for appreciable variation in this species, separation into more narrowly defined taxa does not appear practicable, at least as far as the laevigate forms are concerned.

Distribution.—Givetian and Frasnian of Russian Platform (Naumova 1953); Upper Etonvale Formation (Adavale Basin).

Genus STENOZONOTRILETES (Naumova) Hacquebard 1957

Stenozonotriletes simplex Naumova 1953

Plate 6, Figures 11 and 12.

Description (based on Queensland specimens).—Amb sub-triangular or rounded triangular. Diameter (based on 23 measured specimens) 20 to 49 microns. Trilete; laesurae straight, distinct to inconspicuous, where evident extending to inner margin of cingulum, without marked development of lips. Cingulum 2 to 6 microns in width, laevigate, light to dark brown in colour, inner and outer margins entire and conformable in outline. Central area laevigate, light yellow to light brown in colour.

Figured specimen (Plate 6, Figure 11).—Slide O.D. 2584, stage co-ordinates 41·6, 99·1; diameter 26 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 86·7.

Locality.—P.S. Etonvale No. 1, Core 18, 8,441 ft. 8 in.

Figured specimen (Plate 6, Figure 12).—Slide O.D. 2587, stage co-ordinates 40·3, 94·3; diameter 28 microns. Co-ordinates of lower right-hand corner of cover glass 47·0, 82·0.

Locality.—P.S. Etonvale No. 1 well, Core 18, 8,441 ft. 8 in.

Remarks.—Although slightly smaller (20 to 49 microns) as compared with the size range (30 to 60 microns) quoted by Naumova (1953, pp. 36, 69, 130) the Queensland spores conform in all other respects to her description and figures of *Stenozonotriletes simplex.* The species is long-ranged, as might be expected from its simple, generalised construction.

Distribution.—Devonian, Carboniferous, Permian and Mesozoic of U.S.S.R. (Naumova 1953); Lower Carboniferous of Spitsbergen (Playford 1962); Etonvale Formation (Adavale Basin).

Subturma PSEUDOSACCITITRILETES Richardson 1965

Infraturma INTRORNATI Butterworth and Williams 1958

Genus ENDOSPORITES Wilson and Coe 1940.

Remarks.—The writer is in agreement with Playford (1963A, p. 651), who assigned to *Endosporites,* rather than to *Auroraspora,* the species *Endosporites micromanifestus* Hacquebard 1957 and *Endosporites macromanifestus* Hacquebard 1957. Although other authors have distinguished *Auroraspora* from *Endosporites* by the absence of an equatorial limbus in the former, Playford questions this distinction (1963a, p. 651) "since the original diagnosis of the latter genus (Wilson and Coe 1940, p. 184), which is still accepted unemended, and a recent morphological amplification of the type species (Wilson 1960) contain no reference to an equatorial bladder thickening (limbus)".

Endosporites sp. cf. *E. micromanifestus* Hacquebard 1957

Plate 6, Figure 10

Figured specimen (Plate 6, Figure 10).—Slide O.D. 2646, stage co-ordinates 42·7, 88·6; diameter 64 microns. Co-ordinates of lower right-hand corner of cover glass 47·8, 83·9.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—The four specimens observed have a size range from 64 to 99 microns and are in most respects similar to spores of this species described by Hacquebard (1957, p. 317), Richardson (1965, p. 586) and Playford (1963a, p. 652). They differ slightly in that the central body is appreciably darker than in specimens figured by those authors. It is not clear whether this is an effect of preservation but as only four specimens are available for comparison they are compared, rather than identified, with Hacquebard's species.

Distribution.—Lower Carboniferous of Nova Scotia (Hacquebard 1957), Scotland (Love 1960), Spitsbergen (Playford 1963a), Donetz Basin, U.S.S.R. (Ischenko 1956); Middle Devonian of Scotland (Richardson 1965); Etonvale Formation (Adavale Basin).

Endosporites sp. cf. *E. macromanifestus* Hacquebard 1957

Plate 7, Figure 1.

Figured specimen (Plate 7, Figure 1).—Slide O.D. 2567, stage co-ordinates 34·8, 85·9; dimensions 132 x 92 microns. Co-ordinates of lower right-hand corner of cover glass 47·1, 85·5.

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Remarks.—Only one specimen has been observed; the central body, like that of the specimens recorded above under *Endosporites* cf. *E. micromanifestus,* is relatively dark and for this reason it is compared, rather than identified with *E. macromanifestus* Hacquebard.

Distribution.—Lower Carboniferous of Nova Scotia (Hacquebard 1957); Middle Devonian of Scotland (Richardson 1965); Etonvale Formation (Adavale Basin).

Endosporites gilmorensis, sp. nov.

Plate 7, Figures 2 and 3

Diagnosis.—Amb convexly sub-triangular. Diameter (based on 105 measured specimens) 40 to 150 microns. Trilete; laesurae inconspicuous to imperceptible, where evident extending to, or almost to, equator without development of folds or lips. Intexine thin, laevigate, well defined, diameter about two-thirds that of amb, outline more or less conformable. Exoexine thin, occasionally folded, laevigate, scabrate or finely granulate.

Holotype (Plate 7, Figure 2).—Slide O.D. 2442, stage co-ordinates 38·8, 93·3; diameter 92 microns. Co-ordinates of lower right-hand corner of cover glass 46·7, 84·7.

Locality.—P.S. Gilmore No. 1 well, Core 9, 10,937 ft. 6 in.

Figured specimen (Plate 7, Figure 3).—Slide O.D. 2279, stage co-ordinates 37·6, 95·1; diameter 61 microns. Co-ordinates of lower right-hand corner of cover glass 47·1, 81·4.

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Remarks.—This species is distinguished from *Endosporites micromanifestus,* Hacquebard and *E. macromanifestus* Hacquebard, recorded above, by the absence of flange-like thickenings accompanying the trilete mark. In the inconspicuous or indefinite nature of the laesurae, which is a persistent feature of the specimens examined, it also differs from other species of *Endosporites* recorded in Devonian and Carboniferous microfloras.

Spores assigned to this species have a fairly wide size range (40 to 150 microns). However study of both size distribution and distinctness of the ornament of the exoexine indicates continuous variation in both these features. The specific name refers to the provenance of the holotype from a core of the Phillips–Sunray Gilmore No. 1 well.

Distribution.—Etonvale Formation (Adavale Basin).

Infraturma EXTRORNATI Butterworth and Williams 1958

Genus GEMINOSPORA Balme 1960

Geminospora lemurata Balme 1960

Plate 10, Figures 1, 2, 3, 7, 8, 10, and 11

Description (based on Queensland specimens).—Amb rounded triangular to sub-circular. Diameter (based on 73 measured specimens) 35 to 66 microns. Distal exine flattened hemispherical, proximal exine flattened pyramidal. Trilete; laesurae with slight to distinct development of lips, extending to, or almost to, equator. Exine two-layered; heavily thickened exoexine, 3 to 5 microns thick at equator, enclosing a mesosporoid. Mesosporoid sub-circular to rounded triangular, laevigate, hyaline, lying within the central cavity of the spore. Exoexine ornamented on the distal side with close packed grana, minute coni or papillate projections. Basal diameter of individual sculptural elements about 1 micron, height 1 micron or less, spaced about 1 micron apart. Contact facets smooth.

Figured specimen (Equatorial focus—Plate 10, Figure 1).—Slide O.D. 2623, stage co-ordinates 42·0, 91·2; diameter 61 microns. Co-ordinates of lower right-hand corner of cover class 48·3, 86·4.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Proximal, distal foci—Plate 10, Figures 2 and 3).—Slide O.D. 2279, stage co-ordinates 41·9, 89·1; diameter 46 microns. Co-ordinates of lower right-hand corner of cover glass 47·1, 81·4.

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Figured specimen (Proximal, distal foci—Plate 10, Figures 7 and 8).—Slide O.D. 2625, stage co-ordinates 30·0, 90·0; diameter 56 microns. Co-ordinates of lower right-hand corner of cover glass 46·6, 85·7

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Proximal, equatorial foci—Plate 10 and 11).—Slide O.D. 2622, stage co-ordinates 30·0, 88·5; diameter 53 microns. Co-ordinates of lower right-hand corner of cover glass 47·8, 86·2.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—Identification of the Queensland specimens with *Geminospora lemurata* (in particular those figured in this paper) has been confirmed by Mr. B. E. Balme (Personal communication). Like the spores from Western Australia, they show a fairly wide variation in both size and morphology. However the available evidence indicates continuous gradation both in total diameter and in the size and shape of the sculptural elements.

Distribution.—Gneudna Formation of Western Australia (Balme 1960); late Middle or early Upper Devonian of North Africa (Balme, Personal communication); late Middle or early Upper Devonian of Pertnjara Formation (Northern Territory) (Hodgson 1964); Upper Etonvale Formation (Adavale Basin).

Geminospora micrograna, sp. nov.

Plate 10, Figures 4, 5 and 6

Diagnosis.—Amb rounded sub-triangular to sub-circular. Diameter (based on 15 measured specimens) 25 to 33 microns. Exine two layered; thickened exoexine (1·5 to 3 microns thick at equator) enclosing a mesosporoid lying within the central cavity of the spore. Mesosporoid smooth, hyaline, outline sub-triangular to sub-circular, generally conformable with amb, diameter about three-quarters spore diameter. Trilete, distinct laesurae, without any marked development of lips, extend to limits of mesosporoid. Proximal exoexine laevigate, distal side finely granulate (closely packed projections 0·5 micron or less in diameter), finely scabrate or laevigate.

Holotype (Proximal, distal foci—Plate 10, Figures 5 and 6).—Slide O.D. 2624, stage co-ordinates 35·7, 86·2; diameter 32 microns. Co-ordinates of lower right-hand corner of cover glass 46·7, 81·5.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Distal focus—Plate 10, Figure 4).—Slide O.D. 2627, stage co-ordinates 44·9, 99·1; diameter 25 microns. Co-ordinates of lower right-hand corner of cover glass 47·4, 85·7.

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—The specific name refers to the finely granulate character of the distal exoexine, observed in the holotype and other well preserved specimens. The species differs from *Geminospora lemurata* Balme in being appreciably smaller (diameter 25 to 33 microns as compared with 38 to 67 microns quoted by Balme for his species) and in having a more finely ornamented distal exoexine, which is also significantly thinner than that of Balme's species. The ornamentation of the distal exoexine shows a gradation, in the specimens examined, from finely granulate, to finely scabrate, to laevigate. Although Balme (1960, p. 4) specified distal ornamentation of the exoexine as a diagnostic character of *Geminospora,* the distally smooth specimens of *G. micrograna* are included in the species without formally emending Balme's generic diagnosis. This is because the distal exoexine in the better preserved specimens is finely, but distinctly, granulate; its smooth character in some specimens may be the result of corrosion during deposition or processing of the sample.

Among described species *Archaeozonotriletes purus* Naumova (Naumova 1953, p. 30) resembles *G. micrograna* in having a similar size range, in the laesurae extending to the limits of the mesosporoid and in the width of the equatorial thickening. However, in the description of the Russian species, no mention is made of differentiation in sculpture between proximal and distal surfaces of the exoexine, which is reported as entirely smooth. Consequently, although the smooth (? over-macerated) specimens of *G. micrograna* are very similar to *A. purus,* the species must be regarded as distinct on present evidence.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Turma MONOLETES Ibrahim 1933
Subturma AZONOMONOLETES Luber 1935
Infraturma LAEVIGATOMONOLETI Dybova and Jachowicz 1957

Laevigatosporites sp.

Plate 10, Figure 9

Description.—Amb suboval; dimensions (one specimen) 30 x 16 microns, Monolete, open laesura extending about half length of spore. Exine laevigate, of medium thickness, light brownish yellow.

Figured specimen (Plate 10, Figure 9).—Slide O.D. 2648, stage co-ordinates 43·0, 86·5; dimensions 30 x 16 microns. Co-ordinates of lower right-hand corner of cover glass 47·9, 85·6.

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—Specific identification of this specimen has not been attempted; in the absence of distinctive sculpture, grouping into species of smooth monolete spores of this type is a difficult problem. In such cases specific differentiation must depend largely on size distribution studies, which cannot be attempted on the basis of a single specimen. From the stratigraphic aspect, however, the presence of the genus in these Middle Devonian sediments is of considerable interest. Monolete spores have not yet been recorded from the Lower Devonian, and there is only one previous record of their occurrence in the Middle Devonian. This is from the upper Eifelian of the South Ural region, in the U.S.S.R. (Tschibrickova 1962, pp. 448-451). This specimen and the specimens of *Latosporites* sp., recorded below, are thus close in time to the first known appearance of spores with monolete laesurae.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Genus LATOSPORITES Potonié and Kremp 1954

Latosporites sp.

Plate 10, Figure 12.

Description.—Amb very broadly oval, almost subcircular; dimensions (one specimen) 43 x 36 microns. Monolete, laesura, partly opened, extends almost full length of spore. Exine laevigate or very faintly scabrate, about 1 micron in thickness, colour light yellow.

Figured specimen (Plate 10, Figure 12).—Slide O.D. 2280; stage co-ordinates 40·9, 90·9, dimensions 43 x 36 microns. Co-ordinates of lower right-hand corner of cover glass 46·8, 84·3.

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Remarks.—For the same reason as indicated above, under *Laevigatosporites,* specific assignment of this, the only specimen of *Latosporites* observed, has not been attempted.

Distribution.—Upper Etonvale Formation (Adavale Basin).

INCERTAE SEDIS

Genus SPINOZONOTRILETES Hacquebard 1957

Spinozonotriletes sp. cf. *S. naumovii* (Kedo) Richardson 1965

Plate 9, Figures 1, 2, 3, 4 and 6

Description (based on Queensland specimens.—Amb circular or sub-circular. Diameter (based on 8 measured specimens) 132 to 198 microns. Trilete; laesurae inconspicuous or ill defined. Exoexine ornamented, in distal and equatorial regions, with conical spines, about 10 to 20 microns in length, averaging 10 microns in basal diameter, scattered fairly uniformly (about 20 around equator). Remainder of exoexine (between spines) with scabrate or pitted sculpture. Intexine laevigate, outline generally conformable with amb, distinctly darker than exoexine.

Figured specimen (Proximal, distal and equatorial foci—Plate 9, Figures 1, 4 and 6).—Slide O.D. 2558, stage co-ordinates 31·4, 89·1; diameter 191 microns. Co-ordinates of lower right-hand corner of cover glass 47·4, 82·3.

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Figured specimen (Plate 9, Figures 2 and 3).—Slide O.D. 2557, stage co-ordinates 35·7, 95·7. Co-ordinates of lower right-hand corner of cover glass 47·8, 84·8. (Scabrate exoexine and spines at higher magnification).

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Remarks.—Because of the relatively large size of this species, there is a tendency for it to be represented by broken specimens in the Queensland assemblages. The size recorded above is based on eight relatively complete specimens. The general morphology and distribution of the spines is indicated by Plate 9, Figures 1, 4 and 6 which illustrate a complete, slightly folded specimen at proximal, distal and equatorial foci. The spines and scabrate exoexine between the spines (from another specimen) are illustrated at higher magnification in Plate 9, Figures 3 and 2 respectively.

The Queensland specimens show a close resemblance to *Archaeozonotriletes naumovii* Kedo 1955, transferred by Richardson (1965, p. 583) as a new combination to *Spinozonotriletes*. The size range (132 to 198 microns) is very similar to that of the Russian species (150 to 200 microns). There is also close similarity in the shape of the spines and the scabrate nature of the exoexine. The only difference observed which it is considered could possibly be significant is that the spines are somewhat smaller, being 10 to 20 microns in length in the Queensland specimens, as compared with 10 to 30 microns quoted by Kedo (1955, p. 33). For this reason the spores recorded here are compared, rather than identified with the Russian species.

Richardson (1965, p. 583) has described spores from the Eday beds (Givetian) of Scotland as *Spinozonotriletes* cf. *naumovii* (Kedo). As stated by that author "The spores described here closely resemble *Archaeozonotriletes naumovii* Kedo (Pl. 4, fig. 8, 1955). The size range of the Scottish spores is greater but in the nature of the flange and distribution of the spines they appear identical". The Queensland specimens are similar to these Scottish spores in most respects, the principal difference being in the length of the spines (10 to 20 microns in the former as compared with 15 to 44 microns quoted by Richardson). In this respect, as indicated above, they also differ from Kedo's specimens. In view of the small number of specimens examined from the Adavale Basin, it seems preferable to await study of further material, to enable the full significance of this apparent difference in spine length to be assessed, as far as specific identification with the Russian and Scottish spores is concerned.

Distribution.—Etonvale Formation (Adavale Basin).

Genus ANCYROSPORA (Richardson) Richardson 1965

Ancyrospora parva, sp. nov.

Plate 7, Figures 4 to 13

Diagnosis.—Amb rounded sub-triangular to sub-circular. Diameter (excluding spines, based on 42 measured specimens), 69 to 115 microns. Spore consisting of a relatively thick, laevigate intexine (central body) enclosed in an ornamented exoexine. Diameter of central body about three-quarters that of amb, outline sub-triangular or sub-circular. Trilete; laesurae usually distinct, straight, extending to limits of central body. Lips of intexine frequently folded back from laesurae to form a sub-triangular thinner area; Y-shaped ridge of exoexine, parallel to laesurae and overlying trilete mark, present in some specimens. Exoexine ornamented in equatorial and distal regions with large spines, about 10 to 15 around equator. Spines conical or sub-conical, length 6 to 20 microns, diameter of bases 5 to 14 microns. Projections tending to be slightly smaller and more rounded in distal regions. Apices of spines rounded or bluntly pointed, rarely bifurcating. Broad bases of spines frequently united to form a pseudo-flange at the equator. Exoexine, apart from spines, scabrate or finely pitted; sculpture coarser at bases of spines.

Holotype (Plate 7, Figures 4, 9, 10, and 13).—Slide O.D. 2623, stage co-ordinates 34·6, 97·7; diameter (excluding spines) 92 microns. Co-ordinates of lower right-hand corner of cover glass 48·3, 86·4 (Figures 9 and 10 illustrate spines at higher magnification (x 1000) and Figure 13 illustrates the open trilete mark and scabrate exoexine).

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Figured specimen (Plate 7, Figures 5 and 11).—Slide O.D. 2440, stage co-ordinates 41·6, 97·7; dimensions (excluding spines 82 x 69 microns. Co-ordinates of lower right-hand corner of cover glass 47·8, 83·0. (Figure 11 illustrates a broken bifid spine at higher magnification).

Figured specimen (Plate 7, Figures 6 and 12).—Slide O.D. 2441, stage co-ordinates 28·7, 91·4; diameter 99 microns. Co-ordinates of lower right-hand corner of cover glass 46·5, 85·4. (Figure 12 illustrates a broken bifid spine at higher magnification).

Figured specimen (Plate 7, Figure 7).—Slide O.D. 2441, stage co-ordinates 36·9, 87·5; diameter 69 microns. Co-ordinates of lower, right-hand corner of cover glass 46·5, 85·4.

Figured specimen (Plate 7, Figure 8).—Slide O.D. 2452, stage co-ordinates 41·6, 100·9; dimensions 79 x 69 microns. Co-ordinates of lower right-hand corner of cover glass 48·7, 87·2.

Remarks.—The general structure of the species is illustrated by five representative specimens (Plate 7, Figures 4-8). The rolling back of the intexine adjacent to the trilete mark is shown by Plate 7, Figures 4, 5, 7 and 13 (the last at higher magnification), while in Plate 7, Figure 7 are evident the three ridges of exoexine, overlying the trilete mark in some specimens. A broken specimen (Plate 7, Figure 6) shows how the central body is enclosed by the exoexine and also indicates the laevigate character of the former. Figure 13 also illustrates the fine ornamentation of the exoexine.

Variation in the character of the spines is shown by the figures of complete specimens and by Plate 7, Figures 9-12 (single spines at higher magnification). The majority of the spines are acutely pointed, as shown by most of the projections of the specimen in Plate 7, Figure 4. Some, particularly on the distal surface, have more rounded extremities, as indicated by Plate 7, Figure 10. A small proportion of the spines have bifurcate extremities, an entire example being shown in Figure 9. The fragility of some of these bifurcate spines is illustrated by Figures 11 and 12, which show spines evidently broken when adding the cover glasses to their respective microslides. As a consequence of this fragility, it seems likely that some of the spines, with broken ends, in other specimens, may originally have had bifurcate extremities.

The trilete character of these spores, presence of an intexine and the occurrence of spines with bifurcate extremities, all indicate that this species should be assigned to *Ancyrospora.* With one exception, it differs from other species of this genus in being significantly smaller; in addition the proportion of bifurcate spines is much smaller than in typical representatives of *Ancyrospora.* The exception is *Ancyrospora simplex* Guennel, from a Devonian assemblage from southern Illinois (Guennel 1963, p. 257) which resembles the Queensland specimens in size, nature of the laesurae, the fine sculpture of the exoexine and the dominance of spines with broken, rounded or pointed apices. However Guennel did not observe any spines with bifurcate extremities in specimens of *A. simplex.* An additional feature in which his species differs from the Queensland spores is in the presence of spines tipped by gland-like bulbous structures, which have not been observed in any of the specimens from the Adavale Basin. For these reasons the latter, although similar to *A. simplex* in many features, have been assigned to a distinct, new species. The writer's decision to propose a new species for the Queensland specimens, on the basis of our present knowledge of *A. simplex* and *A. parva,* is supported by Dr. Guennel (Personal communciation).

Hodgson (1964, p. 5) recorded specimens as *Ancyrospora* cf. *A. simplex* from the Devonian of the Amadeus Basin of Central Australia. These spores resemble the Queensland specimens in all diagnostic features, including the presence of a small proportion of bifurcate spines, and it is considered that they are specifically identifiable with *A. parva.*

Distribution.—Middle and Upper Etonvale Formation (Adavale Basin), Pertnjara Formation, Amadeus Basin (Hodgson 1964).

Ancyrospora sp. cf. *A. ancyrea* (Eisenack) Richardson 1962

Plate 8, Figures 9 to 12

Figured specimen (Plate 8, Figures 10 and 11).—Slide O.D. 852, stage co-ordinates 36·2, 98·7. Co-ordinates of lower right-hand corner of cover glass 46·0, 87·0. (Figure 11 illustrates one of the spines of the specimen in Figure 10 at higher magnification).

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Figured specimen (Plate 8, Figures 9 and 12).—Slide O.D. 2562, stage co-ordinates 37·2, 90·2. Co-ordinates of lower right-hand corner of cover glass 47·5, 83·5. (Figure 9 illustrates one of the spines of the specimen in Figure 12 at higher magnification).

Locality.—P.S. Etonvale No. 1 well, Core 20, 8,767 ft.

Remarks.—With the exception of *Ancyrospora parva* sp. nov., recorded above, specimens of *Ancyrospora* are relatively rare in the Queensland assemblages, and complete well preserved specimens are even less common. The two specimens figured, although fragmentary, are recorded because in overall size and in the nature and distribution of the spines they are comparable with *A. ancyrea* (Eisenack) Richardson. One of the specimens (Plate 8, Figure 10) also has the distinct sub-triangular "central body" regarded by Richardson (1962 p. 177) as a characteristic specific feature. It will be necessary to await discovery of more complete and better preserved specimens before confirming the presence of this widespread Devonian species in the Adavale Basin.

Distribution.—Middle Etonvale Formation (Adavale Basin).

Ancyrospora sp. A

Plate 8, Figures 1-8.

Description.—Amb rounded sub-triangular to sub-circular. Diameter (4 specimens) 136 to 188 microns. Spore consisting of a laevigate intexine (central body) enclosed in an ornamented exoexine. Central body with diameter about half that of amb, centrally located, outline more or less conformable. Prominent triradiate folds associated with laesurae, extend to periphery of amb. Distal and equatorial regions of exoexine ornamented with short spines (some with bifurcating ends) 5 to 11 microns in length, with expanded bases 5 microns in diameter, together with rounded verrucae about 3 to 5 microns in diameter. Sculptural elements sparsely distributed; intervening exoexine (between larger elements) finely granulate or scabrate.

Figured specimen (Plate 8, Figures 1, 5 and 8).—Slide O.D. 2281, stage co-ordinates 41·8, 90·7, diameter 188 microns. Co-ordinates of lower right-hand corner of cover glass 46·0, 84·8 (Figures 5 and 8 illustrate respectively a group of verrucae and a bifid equatorial spine at higher magnification).

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Figured specimen (Plate 8, Figures 2, 4 and 6).—Slide O.D. 2282, stage co-ordinates 44·6, 91·0; diameter 168 microns. Co-ordinates of lower right-hand corner of cover glass 45·9, 85·1. (Figures 4 and 6 illustrate respectively a group of verrucae and a bifid equatorial spine at higher magnification).

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Figured specimen (Plate 8, Figures 3 and 7).—Slide O.D. 2280, stage co-ordinates 35·8, 85·9; diameter 151 microns. Co-ordinates of lower right-hand corner of cover glass 46·8, 84·3. (Figure 7 illustrates a bifid equatorial spine at higher magnification).

Locality.—Amoseas Boree No. 1 well, Core 17, 6,206 ft.

Remarks.—This species differs from previously described species of *Ancyrospora* in the small size of the bifid spines, relative to the overall diameter, and in the presence of rounded distal verrucae. As only four specimens have been observed, formal taxonomic designation must await study of further material.

Distribution.—Upper Etonvale Formation (Adavale Basin).

Ancyrospora sp.

Plate 9, Figures 5 and 7.

Figured specimen (Plate 9, Figures 5 and 7).—Slide O.D. 2624, stage co-ordinates 30·4, 88·1; diameter (excluding spines) 73 microns. Co-ordinates of lower right-hand corner of cover glass 46·7, 81·5. (Figure 5 illustrates a spine at higher magnification).

Locality.—P.S. Gumbardo No. 1 well, Core 5, 8,336 ft. 1 in.

Remarks.—The specimen figured differs from *Ancyrospora ancyrea* (Eisenack) Richardson and *A. grandispinosa* Richardson in being appreciably smaller and in having a less distinct central body. *A. longispinosa* Richardson is much larger and has much longer spines. While it is of comparable size to *A. parva,* sp. nov., the specimen also differs from that species in having longer spines in relation to the spore diameter, a greater proportion of them having bifurcate apices; the central body is also less distinct than in that species.

Gen. Nov. A

Plate 4, Figures 6, 7 and 10

Figured specimen (Plate 4, Figures 6, 7 and 10).—Slide O.D. 2647, stage co-ordinates 38·7, 98·9; diameter 92 microns. Co-ordinates of lower right-hand corner of cover glass 47·5, 83·8. Figures 6 and 7 illustrate biform sculptural elements at higher magnification).

Locality.—P.S. Gumbardo No. 1 well, Core 6, 8,705 ft.

Remarks.—This specimen resembles *Dibolisporites* Richardson 1965 in the biform nature of the sculptural elements, but differs in having a distinct intexine. Thus it must be regarded as generically distinct, but adequate knowledge of generic and specific characters must await study of further material.

MICROFLORAL ASSEMBLAGES

Microfloral assemblages are listed below for each well in ascending stratigraphic order.

(a) Phillips–Sunray Etonvale No. 1 Well

Core 24, 10,002 ft.

Apiculatisporis adavalensis	3·0%
Cyclogranisporites sp.	7·5%
Dictyotriletes australis	0·5%
Endosporites gilmorensis	0·5%
Granulatisporites sp.	12·5%
G. phillipsi	25·5%
Leiotriletes sp.	17·5%
Leiotriletes sp. A	22·0%
Pilasporites sp.	1·5%
Punctatisporites sp.	5·5%
P. etonvalensis	1·0%
Spinozonotriletes cf. *naumovii*	0·5%
Indeterminate	2·5%

Core 23, 9,610 ft.

Apiculatisporis adavalensis	1·0%
Calamospora sp.	0·4%
Cyclogranisporites sp.	6·6%
Dictyotriletes australis	0·4%
Granulatisporites sp.	2·4%
G. phillipsi	10·8%
Hystricosporites richardsoni	0·2%
Leiotriletes sp.	6·4%
Leiotriletes sp. A	53·6%
Pilasporites sp.	5·6%
Punctatisporites sp.	6·6%
Retusotriletes simplex	0·4%
Schopfites microverrucatus	0·6%
Stenozonotriletes simplex	0·6%
Indeterminate	4·4%

Core 22, 9,333 ft. 3 in.

Apiculatisporis adavalensis	2·5%
Calamospora sp.	0·25%
Cyclogranisporites sp.	36·75%
Dictyotriletes australis	1·75%
Endosporites gilmorensis	1·0%
Granulatisporites sp.	1·5%
G. phillipsi	4·25%
Hystricosporites richardsoni	0·75%
Leiotriletes sp.	5·0%
Leiotriletes sp. A	24·0%
Pilasporites sp.	3·5%
Punctatisporites sp.	13·0%
Retusotriletes simplex	0·25%
Schopfites microverrucatus	0·75%
Spinozonotriletes cf. *naumovii*	0·25%
Verrucosisporites pulvinatus	0·5%
Indeterminate	4·0%

Core 21, 9,095 ft. 4 in.

Apiculatisporis adavalensis	1·0%
Cyclogranisporites sp.	55·0%
Dictyotriletes australis	0·5%
Endosporites gilmorensis	1·0%
Granulatisporites sp.	0·5%
G. phillipsi	1·5%
Hystricosporites richardsoni	1·5%
Leiotriletes sp.	4·5%
Leiotriletes sp. A	12·0%
Pilasporites sp.	4·0%
Punctatisporites sp.	9·0%
Schopfites microverrucatus	1·0%
Stenozonotriletes simplex	1·5%
Verrucosisporites pulvinatus	0·5%
Indeterminate	6·5%

Core 20, 8,767 ft.

Ancyrospora cf. *ancyrea*	0·4%
A. parva	0·2%
Apiculatisporis adavalensis	1·6%
Cyclogranisporites sp.	46·2%
Densosporites sp.	0·2%
Dictyotriletes australis	0·4%
Endosporites gilmorensis	4·4%
Granulatisporites sp.	2·4%
G. phillipsi	2·6%
Hystricosporites richardsoni	2·2%
Leiotriletes sp.	3·8%
Leiotriletes sp. A	4·2%
Pilasporites sp.	4·0%
Punctatisporites sp.	13·4%
Retusotriletes pychovii	0·2%
R. simplex	0·2%
Schopfites microverrucatus	1·6%
Spinozonotriletes cf. *naumovii*	1·0%
Stenozonotriletes simplex	1·0%
Verrucosisporites pulvinatus	0·8%
Indeterminate	9·2%

Core 18, 8,441 ft. 8 in.

Ancyrospora parva	1·0%
Calamospora sp.	0·5%
Cyclogranisporites sp.	59·5%
Endosporites gilmorensis	0·5%
E. cf. *micromanifestus*	0·5%
Granulatisporites phillipsi	4·0%
Hystricosporites richardsoni	0·5%
Leiotriletes sp.	0·5%
Leiotriletes sp. A	3·0%
Pilasporites sp.	1·5%
Punctatisporites sp.	17·5%
Stenozonotriletes simplex	2·5%
Verrucosisporites pulvinatus	1·5%
Indeterminate	6·5%

Core 17, 8,278 ft. 5 in.

Apiculatisporis adavalensis	1·0%
Cyclogranisporites sp.	55·0%
Dibolisporites sp.	0·5%
Dictyotriletes australis	0·5%
Endosporites gilmorensis	2·0%
Granulatisporites sp.	2·5%
G. phillipsi	1·0%
Hystricosporites richardsoni	0·5%
Leiotriletes sp.	4·5%
Leiotriletes sp. A	9·0%
Phyllothecotriletes nigratus	0·5%
Pilasporites sp.	6·0%
Punctatisporites sp.	12·0%
Schopfites microverrucatus	1·5%
Stenozonotriletes simplex	0·5%
Indeterminate	3·0%

Core 16, 8,058 ft. 11 in.

Ancyrospora parva	1·0%
Apiculatisporis adavalensis	2·0%
Calamospora sp.	0·5%
Cyclogranisporites sp.	22·5%
Dictyotriletes australis	1·0%
Endosporites gilmorensis	0·5%
Hystricosporites richardsoni	0·5%
Leiotriletes sp.	9·0%
Leiotriletes sp. A	6·5%
Pilasporites sp.	16·0%
Punctatisporites sp.	35·0%
P. etonvalensis	1·0%
Schopfites microverrucatus	1·0%
Stenozonotriletes simplex	2·0%
Indeterminate	1·5%

(b) Phillips–Sunray Gumbardo No. 1 Well

Core 12, 10,318 ft.

Apiculatisporis adavalensis	0·2%
Cyclogranisporites sp.	29·8%
Dictyotriletes australis	0·6%
Endosporites gilmorensis	0·2%
Granulatisporites sp.	2·0%
G. phillipsi	1·2%
Leiotriletes sp.	7·6%
Leiotriletes sp. A	2·6%
Pilasporites sp.	0·4%
Punctatisporites sp.	44·4%
P. etonvalensis	0·4%
Retusotriletes simplex	0·6%
R. cf. *tenerimedium*	0·2%
Schopfites microverrucatus	1·2%
Spinozonotriletes cf. *naumovii*	0·2%
Indeterminate	8·4%

Core 11, 9,896 ft.

Calamospora sp.	1·0%
Cyclogranisporites sp.	26·0%
Dictyotriletes australis	1·0%
Endosporites gilmorensis	1·0%
Granulatisporites sp.	4·0%
Leiotriletes sp.	13·0%
Leiotriletes sp. A	8·0%
Phyllothecotriletes nigratus	1·0%
Pilasporites sp.	6·0%
Punctatisporites sp.	12·0%
Schopfites microverrucatus	4·0%
Indeterminate	23·0%

Core 10, 9,561 ft. 5 in.

Ancyrospora parva	0·2%
Calamospora sp.	0·6%
Cyclogranisporites sp.	41·2%
Dictyotriletes australis	1·0%
Endosporites gilmorensis	0·8%
Granulatisporites sp.	3·8%
G. phillipsi	0·2%
Leiotriletes sp.	1·6%
Leiotriletes sp. A	16·0%
Pilasporites sp.	1·2%
Punctatisporites sp.	20·8%
P. etonvalensis	0·2%
Retusotriletes cf. *devonicus*	0·2%
R. simplex	0·6%
R. tenerimedium	0·2%
Schopfites microverrucatus	2·4%
Indeterminate	9·0%

Core 6, 8,705 ft.

Ancyrospora parva	0·2%
Apiculatisporis adavalensis	0·8%
Calamospora sp.	0·2%
Cyclogranisporites sp.	9·4%
Densosporites atavus	37·0%
Dibolisporites sp.	0·2%
Endosporites gilmorensis	3·4%
E. cf. *micromanifestus*	0·4%
Granulatisporites sp.	0·6%
G. phillipsi	1·4%
Heterotriletes priscus	3·6%
Hystricosporites sp. A	0·4%
Laevigatosporites sp.	0·2%
Leiotriletes sp.	0·8%
Leiotriletes sp. A	6·4%
Pilasporites sp.	1·6%
Punctatisporites sp.	12·0%
Gen. Nov. A	0·2%
Indeterminate	11·2%

Core 5, 8,336 ft. 1 in.

Ancyrospora sp.	0·2%
A. parva	1·0%
Apiculatisporis adavalensis	26·8%
Archaeozonotriletes variabilis	0·2%
Chomotriletes sp.	0·4%
Cyclogranisporites sp.	9·8%
Emphanisporites sp.	0·2%
Endosporites gilmorensis	0·2%
Geminospora lemurata	14·6%
G. micrograna	2·4%
Granulatisporites sp.	1·0%
Leiotriletes sp.	4·4%
Leiotriletes sp. A	9·2%
Pilasporites sp.	7·6%
Punctatisporites sp.	7·4%
Retusotriletes pychovii	0·4%
Stenozonotriletes simplex	0·6%
Indeterminate	3·6%

(c) Phillips–Sunray Gilmore No. 1 Well

Core 16, 12,847 ft. 8 in.

Cyclogranisporites sp.	43·0%
Granulatisporites phillipsi	2·0%
Leiotriletes sp.	3·0%
Leiotriletes sp. A	17·0%
Pilasporites sp.	2·0%
Punctatisporites sp.	24·0%
Retusotriletes simplex	1·0%
Schopfites microverrucatus	2·0%
Indeterminate	6·0%

Core 9, 10,937 ft. 6 in.

Ancyrospora parva	8·4%
Apiculatisporis adavalensis	0·2%
Brochotriletes sp.	0·4%
Calamospora sp.	0·6%
Cyclogranisporites sp.	6·2%
Endosporites gilmorensis	1·2%
Leiotriletes sp.	2·2%
Leiotriletes sp. A	2·8%
Pilasporites sp.	13·0%
Punctatisporites sp.	21·0%
Retusotriletes simplex	32·0%
Indeterminate	12·0%

(d) Amoseas Boree No. 1 Well

Core 17, 6,206 ft.

Ancyrospora sp. A	0·8%
Apiculatisporis adavalensis	0·4%
Calamospora sp.	0·2%
Cyclogranisporites sp.	7·0%
Dibolisporites sp.	0·2%
Endosporites gilmorensis	9·2%
E. cf. *macromanifestus*	0·2%
E. cf. *micromanifestus*	0·2%
Geminospora lemurata	0·8%
Granulatisporites sp.	14·0%
G. phillipsi	2·0%
Hystricosporites sp.	0·6%
Latosporites sp.	0·2%
Leiotriletes sp.	6·8%
Leiotriletes sp. A	31·0%
Phyllothecotriletes nigratus	0·2%
Pilasporites sp.	1·2%
Punctatisporites sp.	6·6%
P. etonvalensis	0·4%
Indeterminate	18·0%

Core 10, 4,776 ft.

Chomotriletes sp.
Leiotriletes sp.
Phyllothecotriletes sp.
Pilasporites sp.
Punctatisporites sp.

(e) Phillips–Sunray Quilberry No. 1 Well

Core 10, 5,932 ft. 4 in.

Cyclogranisporites sp.
Dictyotriletes australis
Endosporites sp.
Granulatisporites sp.
Leiotriletes sp.
Verrucosisporites sp.

(f) Phillips–Sunray Log Creek No. 1 Well

Core 23, 14,351 ft. 7 in.

Calamospora sp.
Cyclogranisporites sp.
Leiotriletes sp.
Punctatisporites sp.
Schopfites microverrucatus

MICROFLORAL SEQUENCES AND CORRELATION OF WELL SECTIONS

Although extensive coring has been undertaken in several wells within the Devonian sequence of the Adavale Basin, samples from many of the cores have given negligible spore yields. This is evident, for example, in the case of the P.S. Quilberry No. 1 well where, out of thirteen cores processed, only one (Core 10, listed above) gave a significant yield of spores. As a result of this dominance of barren samples in many of the cores studied, only in the case of two wells has sufficient evidence been obtained to enable detailed study of the microfloral sequences. In one of these (P.S. Etonvale No. 1), eight cores, distributed over a vertical thickness of approximately 2,000 ft., have yielded well preserved assemblages, while in the other (P.S. Gumbardo No. 1), the sequence, based on assemblages from five cores, also extends over a vertical interval of about 2,000 ft.

Microfloral sequences from these two wells are shown diagrammatically in Figures 2 and 3. As well as showing the percentage distribution of the forms listed and the relative positions of the cores studied, the figures also illustrate the generalised lithological sequences over the relevant intervals.

Lithological correlation of these two sections is largely based on the presence in each of the D3 carbonate member, a persistent marker in this part of the Basin. Correlation of the sections, using this marker, shows that they complement each other in providing a record of the microfloral succession. Thus the Etonvale sequence has provided a record of the microfloras over a thickness of approximately 2,400 ft. of strata below the D3 carbonate member; the cores from the sequence overlying this marker at Etonvale (Cores 12–14) yielded relatively poorly preserved assemblages, which have not been studied in detail. On the other hand the Gumbardo well, while it penetrated a thinner sedimentary section below the D3 member, yielded two cores with well preserved assemblages from the section overlying it, the section so covered being about 630 ft. in thickness. Consequently the two wells, between them, have enabled the microfloral succession within a sequence of about 3,000 ft. of sediments to be investigated.

Study of Figures 2 and 3 indicates that, while some of the species persist through the entire sequence, the remainder fall into two groups, with ranges restricted respectively to sediments below, and above, the D3 carbonate member. The former group includes *Dictyotriletes australis, Punctatisporites etonvalensis, Schopfites microverrucatus, Spinozonotriletes* cf. *naumovii, Hystricosporites richardsoni* and *Verrucosisporites pulvinatus.* Species known only from horizons above this member include *Densosporites atavus, Chomotriletes* sp., *Geminospora lemurata, G. micrograna* and *Archaeozonotriletes variabilis.*

This division of the assemblages into two major groups may be related either to a change in environmental conditions or to the occurrence of a slight hiatus in deposition at the base of the D3 carbonate member. Regarding the latter possibility Heikkila (1965) pointed out "the D3 carbonate obviously reflects more stable sedimentary conditions and specifically the cessation in degradation of the Yaraka Shelf and other possible high areas west and south. Consequently the D3 may be in slight angular unconformity with the D4 which, moreover, evidences loss of section at the top, from Etonvale No. 1 south-westward to Gumbardo". It seems likely, however, from the discussion, recorded below, on the age of the micofloras, that any hiatus below the D3 carbonate member represented a relatively short portion of Devonian time. The loss of section below this member (deduced from geophysical evidence) is supported by study of the distribution of *Ancyrospora parva.* This species first appears in the assemblage from Core 20 of the P.S. Etonvale No. 1 well, about 1,170 ft. below the D3 carbonate member, while in the Gumbardo sequence it is first recorded from Core 10, about 600 ft. below the same marker. This reduced interval at Gumbardo would be in accordance with thinning of the sedimentary section.

In addition to those from the Etonvale and Gumbardo sequences assemblages are listed above from the P.S. Gilmore No. 1, Amoseas Boree No. 1, P.S. Quilberry No. 1 and P.S. Log Creek No. 1 wells. Some evidence on correlation of the sections in these wells with the Etonvale-Gumbardo sequence is provided by comparison of the assemblages. Thus Core 16 of the P.S. Gilmore No. 1 well contains *Schopfites microverrucatus,* a species known only from the section below the D3 carbonate member. Its presence at this level thus supports correlation of the section from 11,910 to 11,955 ft. at Gilmore with the D3 member. Likewise, the presence of *Dictyotriletes australis* in Core 10 of the P.S. Quilberry No. 1 well, supports correlation of the limestone between 5,400 and 5,600 ft. in that well with the same marker. The varied assemblage from Core 17, of the Amoseas Boree No. 1 well, includes *Geminospora lemurata,* a species known elsewhere only from Core 5 of P.S. Gumbardo No. 1. well. Its presence thus favours correlation with an horizon approximately equivalent to, or higher than, this level at Gumbardo.

Finally, the small assemblage from Core 23 of the Log Creek well, while it contains the "pre-D3" species, *Schopfites microverrucatus,* is also of interest from another aspect. As far as is known it represents (at 14,351 ft.) one of the deepest recorded occurrences of spores in Australian sediments. The preservation of determinable spores at this level is promising, as far as future correlation studies in the Adavale Basin are concerned, as it indicates that this considerable depth of burial has not led to marked metamorphism of the spore exines.

AGE OF THE MICROFLORAS

Faunal evidence on the age of the Etonvale Formation has been discussed in a preceding section (see Stratigraphic Summary above). Generally a Middle Devonian age is indicated for most, if not all, the sediments of the Formation. In considering assignment to horizons within the Middle Devonian, the possible occurrence of a break in sedimentation at the base of the D3 carbonate member must be taken into account. Accordingly the sections above and below the base of this member have been considered separately. For the former section faunal studies favour a Givetian (upper Middle Devonian) age, while for sediments correlated with the lower section (see above) a Givetian age has been indicated (Core 15 of the Quilberry well, McKellar 1965c) and also a probable Eifelian age (Core 23 of the Etonvale well, McKellar 1965d). There is insufficient faunal evidence to establish whether the sediments of this lower section are diachronous or whether their deposition extended through both divisions of the Middle Devonian.

The microfloral investigation recorded here has yielded additional data on the age of the Etonvale Formation. One reason for this is that the microfloras have provided a more complete record of the sections studied, as only a few of the cores contained diagnostic marine faunas, while a much greater proportion yielded spore assemblages. In addition, sufficient evidence has accumulated in recent years to enable knowledge of the stratigraphic ranges of the relevant genera and species, present in the assemblages, to be applied in relating the Queensland sections to Devonian sequences elsewhere.

Perhaps the most striking feature of the Queensland assemblages, in comparison with other Devonian microfloras, is the dominance, in many of them, of spores with smooth or finely ornamented exines. This dominance of simple forms contrasts with the abundance of more complex species in most other Middle Devonian assemblages. (For example Middle Devonian assemblages of Scotland often contain as much as 50 per cent. of spores with bifurcate processes (Richardson 1962, p. 172)). As a consequence the writer has suggested a Lower Devonian age for some of the Queensland assemblages in earlier, unpublished, preliminary reports. However it is now clear that this distinctively different composition of the Queensland microfloras is related to local environmental conditions, as the Middle Devonian age of the Etonvale Formation has been indicated not only by evidence from marine faunas but also by additional microfloral evidence.

This additional evidence arises not only from study of further material, but also from advances in knowledge of the stratigraphic ranges of Devonian genera and species. As far as the generic ranges are concerned, these have recently been charted by Richardson (1964). Two genera, *Endosporites* and *Spinozonotriletes,* which range down to the oldest known assemblage in the Etonvale sequence (from Core 24 of P.S. Etonvale No. 1), first appear elsewhere in the Eifelian (Richardson 1964, p. 1113). Another distinctive genus, *Hystricosporites,* also extends through most of the sequence; its absence from the very lowest assemblage may be due to ecological, rather than stratigraphic factors. *Hystricosporites,* likewise, according to Richardson, first appears elsewhere in the Eifelian; the presence of these genera thus favours the view that sediments older than Middle Devonian are not present in the section studied.

The presence of species, previously recorded from Devonian assemblages elsewhere, is probably even more significant than the generic composition of the microfloras, as the specific ranges are generally more restricted. In discussing distribution of significant species, the upper and lower portions of the Etonvale Formation (respectively above and below the base of the D3 carbonate member) are considered separately, in view of the possibility, mentioned above, of a slight time break at the base of this unit.

In the upper part of the Formation, two species—*Archaeozonotriletes variabilis* Naumova and *Geminospora lemurata* Balme—first appear at horizons close to the top of the sequence. The former is first recorded from the Givetian and extends into the Frasnian (Naumova 1953, Tschibrickova 1959). *Geminospora lemurata* was described from the Gneudna Formation of Western Australia, which is of Frasnian age (Veevers 1959, p. 23). This species is also abundant in North African sediments of late Middle or early Upper Devonian age (Balme, Personal communication) and is "morphographically similar to, if not identical with" a spore described from the Givetian of Esthonia (Balme 1960, p. 5). From the evidence available it thus seems likely that both these species made their first appearence within the Givetian; their presence near the top of the upper portion of the Etonvale Formation consequently favours a Givetian age for this section. This is supported by the absence of *Chomotriletes vedugensis* from the Queensland assemblages. Its absence is evidence for a pre-Frasnian age, as it is restricted to the Frasnian of the Russian Platform (Naumova 1953, p. 58) and to the upper part of the Gneudna Formation (Balme 1960, p. 7). Assignment of this upper portion of the Etonvale Formation to the Givetian is in conformity with the probable Givetian age indicated for a marine fauna from Core 8 of the P.S. Quilberry No. 1 well, within this section (McKellar 1965a).

From the lower portion of the Formation (underlying the D3 carbonate member) two significant species have been identified. They are *Phyllothecotriletes nigratus* (Naumova), comb. nov. and *Retusotriletes tenerimedium* Tschibrickova. The former first appears in the Givetian (Naumova 1953) and extends into the Upper Devonian; the latter, a particularly distinctive species, is characteristic of the upper Eifelian and lower Givetian of the Bashkiri region (Tschibrickova 1959, 1962). Two other species from this section have been compared with previously described species. They are *Spinozonotriletes* cf. *naumovii* (Kedo) Richardson and *Retusotriletes* cf. *devonicus* Naumova. *S. naumovii* is restricted to the Givetian (Kedo 1955, Richardson 1965) while *R. devonicus* is known from the upper Eifelian and Givetian (Tschibrickova 1959, 1962). In general terms, the presence of these species, notably the distinctive *R. tenerimedium,* would accordingly favour an upper Eifelian or lower Givetian age.

As far as the marine faunas are concerned, "an Emsian, or more probable Eifelian age" has been suggested for a faunule from near the base of this lower section in the Etonvale well (McKellar 1965d). For a fauna from this lower section in the P.S. Quilberry No. 1 well, the same author (McKellar 1965c) has indicated a Givetian age. This difference in ages determined for faunas from this lower section in the western and eastern parts of the basin may indicate either (*a*) that the sediments of this lower section are diachronous or (*b*) that they extend downwards in age from Givetian to Eifelian. The microfloras, on present evidence, do not enable a choice to be made between these alternatives, although they do indicate that the section is no older than Eifelian. Consequently any time break at the base of the D3 carbonate member is likely to have been of relatively short duration, within the Middle Devonian.

Finally, microfloral studies have provided evidence on the age of the Buckabie Formation, which overlies the Etonvale Formation, apparently conformably. An Upper Devonian-Lower Carboniferous (?) age was suggested by Heikkila (1965) for this unit, which consists of "varicoloured, primarily red, sandstone, thin conglomerate, shale and claystone of continental and shallow marine origin". Cores from this formation are normally devoid of both macro- and microfossils; however one sample from the lower part of the sequence (Core 10 of the Amoseas Boree No. 1 well) has given a low yield of spores. (The writer supports the correlation suggested by Gerrard (1964, p. 36) of the section from 4,457 to 4,982 ft. in this well with the Buckabie Formation). The assemblage from this sample includes a species of *Chomotriletes,* which is also present in the upper part of the Etonvale Formation (Core 5 of the P.S. Gumbardo No. 1 well). Also, like many assemblages from the latter Formation, it is dominated by smooth, or finely ornamented, trilete spores. Accordingly this assemblage is considered to be fairly close in age to the upper part of the Etonvale Formation, i.e. Givetian or Frasnian. Apart from this one assemblage, no data are available on other horizons in the Buckabie sequence; in view of the thickness of the unit, it is possible that deposition of this sequence extended into the Lower Carboniferous.

COMPARISON WITH OTHER AUSTRALIAN DEVONIAN MICROFLORAS

Devonian microfloras have previously been described from three different sequences in Australia. These are (1) The Gneudna Formation of Western Australia, of probable Frasnian age (Balme 1960), (2) the Pertnjara Formation (Amadeus Basin), of late Middle or early Upper Devonian age (Hodgson 1964) and (3) the Famennian sequence of the Canning Basin (Balme and Hassell 1962).

Of these the last-named has yielded the most diverse assemblages. These Famennian microfloras are very different from those of the Adavale Basin. They contain several genera, such as *Convolutispora, Reticulatisporites, Pulvinispora, Cincturasporites* and *Leiozonotriletes,* which are missing from the Etonvale Formation, while the Queensland assemblages include *Ancyrospora, Dictyotriletes, Densosporites, Geminospora* and *Spinozonotriletes,* which are lacking in those described by Balme and Hassell. At the specific level, with the possible exception of *Retusotriletes pychovii,* assemblages from the two areas have very little in common. Balme and Hassell (1962, p. 26) indicate similarities between their assemblages and those described from the Famennian of the U.S.S.R. and North Africa. It is thus evident that the Queensland microfloras ante-date the development of these widespread Famennian microfloral elements.

Balme's older assemblages, from the Gneudna Formation (of probable Frasnian age—Veevers 1959, p. 23) have more in common with the microfloras of the Adavale Basin. Species present in both include *Geminospora lemurata, Retusotriletes pychovii* and also simple forms comparable with *Leiotriletes simplex* Naumova. In addition *Emphanisporites* sp. may be specifically comparable with *"Radiaspora"* sp. A of Balme's assemblages. Stratigraphically, the most significant of these is *Geminospora lemurata.* As indicated above, the appearance of this species near the top of the Etonvale Formation indicates that most, if not all of that unit, is older than the Gneudna Formation. In addition the Frasnian species *Chomotriletes vedugensis* has not been found in the Queensland assemblages. Another aspect in which assemblages from the two areas differ is that, while only one specimen of *Emphanisporites* was recorded in the Queensland assemblages listed above, Balme (1960, p. 6) recorded more numerous specimens with similar radial ornamentation. However, spores of this type were more numerous in a poorly preserved assemblage from Core 12 (6,955 ft.) of the P.S. Etonvale No. 1 well, which, because of the poor preservation of most specimens, was not included in those listed in this paper.

Hodgson (1964) has recorded an assemblage from a sample of the Pertnjara Formation, of the Amadeus Basin (Northern Territory). This assemblage is dated by evidence from vertebrate fossils as Middle or Upper Devonian, probably the latter. It contains abundant *Geminospora lemurata*; this abundance would favour a late Givetian or Frasnian age. The presence of this species distinguishes this assemblage from all those from the Etonvale Formation, except those from two samples near the top of the sequence, in which it makes its first appearance. These two assemblages differ in other respects from that recorded by Hodgson; it thus seems likely that his microflora is of Frasnian age and slightly younger than those from the Etonvale Formation. One interesting feature of the Pertnjara assemblage is the presence of *Ancyrospora* cf. *A. simplex,* regarded as conspecific with the specimens recorded above as *A. parva.* This species first appears over 1,000 ft. above the base of the Etonvale Formation and ranges to the top of the sequence. It thus seems likely that its range in Australia comprises both Givetian and Frasnian horizons.

The conclusion is thus evident that in Middle Devonian times vegetation yielding a diverse microflora developed in the Adavale Basin. Some elements of the assemblages persist into Upper Devonian microfloras recorded from elsewhere in Australia, but in general terms a gradual replacement of the Givetian species took place in the Frasnian. This replacement, as indicated by Balme and Hassell's paper (1962), became almost complete in the Famennian.

COMPARISON WITH DEVONIAN MICROFLORAS FROM THE NORTHERN HEMISPHERE

Richardson (1965) has discussed the relationships of microfloras from the Middle Devonian of Scotland, Germany, Russia and North America. Of these the assemblages from the Orcadian Basin of north-east Scotland have been recently described and are accurately dated (Richardson 1960, 1962, 1965). These assemblages differ markedly from those of the Middle Devonian of the Adavale Basin. They contain abundant spores with bifurcate processes, which are far less common in the Queensland microfloras. Likewise large zonate and pseudosaccate spores, which are common in the Scottish assemblages, are much less abundant in the Adavale samples. At the specific level, spores identifiable, or comparable with, Scottish species are mostly relatively rare in the Queensland assemblages. Among the few species comparable with those recorded by Richardson are *Spinozonotriletes* cf. *naumovii, Endosporites* cf. *micromanifestus* and *Endosporites* cf. *macromanifestus.*

It seems likely that the marked differences between the Scottish and Queensland assemblages are related to differences in environment of deposition. Richardson's assemblages were derived from fresh-water sediments, while those from the Adavale Basin came from sequences of marine, or paralic origin. As Richardson has indicated (1965, p. 597) regarding spores with bifurcate processes: "it is tempting to suggest that plants producing spores having this distinctive ornament were common in, or bordering, fresh-water environments". Similarly differences in environment of deposition may explain the absence or rarity of other Scottish genera in the Queensland assemblages.

Middle Devonian assemblages from the U.S.S.R. and Europe also exhibit many differences from those of the Adavale Basin; these differences, likewise, presumably reflect differences in environment of deposition of the sediments. However, it is interesting to note the presence of several species identifiable, or closely comparable, with Russian species in the Queensland microfloras. These include *Phyllothecotriletes nigratus* (Naumova), comb. nov., *Retusotriletes pychovii* Naumova, *R. simplex* Naumova, *R. tenerimedium* Tschibrickova, *R.* cf. *devonicus* Naumova, *Archaeozonotriletes variabilis* Naumova, *Stenozonotriletes simplex* Naumova and *Spinozonotriletes* cf. *naumovii* (Kedo) Richardson. As some of these species are of distinctive morphology and have restricted stratigraphic ranges, their discovery in this Australian succession is particularly significant in enhancing the development of inter-continental correlation, based on microfloral studies, in the Middle Devonian.

In conclusion, the general result of these comparisons is to indicate the occurrence in the Middle Devonian of the Adavale Basin, of markedly different assemblages from those of the Northern Hemisphere. However the widespread distribution of a few species, present in minor proportions, promises well for their future use in inter-continental correlation.

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PLATE 1

(All photographs approximately x 1000)

Figure 1.—*Pilasporites* sp.

Figure 2.—*Pilasporites* sp.

Figure 3.—*Leiotriletes* sp. A

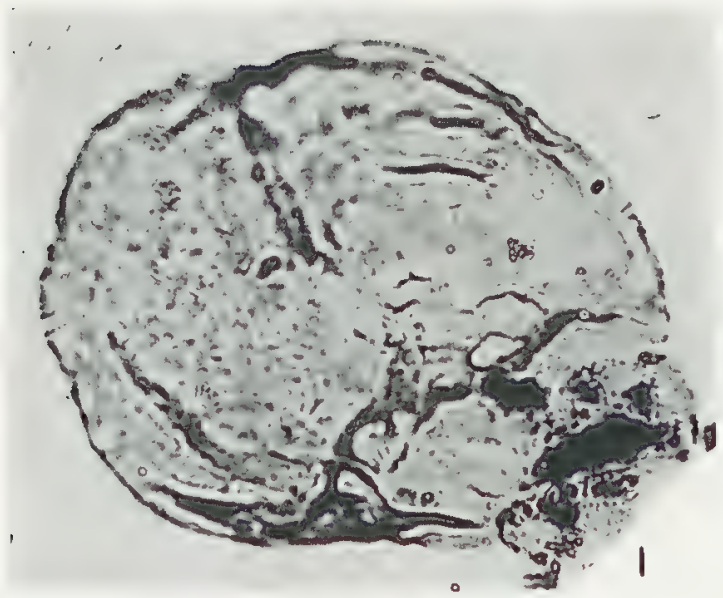
Figure 4.—*Leiotriletes* sp.

Figure 5.—*Punctatisporites etonvalensis*, sp. nov. (Holotype, proximal focus).

Figure 6.—*Punctatisporites etonvalensis*, p. nov. (Proximal focus).

Figure 7.—*Phyllothecotriletes nigratus* (Naumova), comb. nov. (Proximal focus).

Figure 8.—*Phyllothecotriletes nigratus* (Naumova), comb. nov. (Proximal focus).



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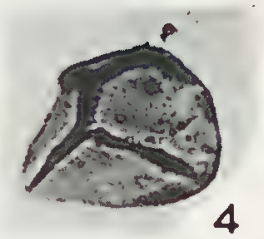

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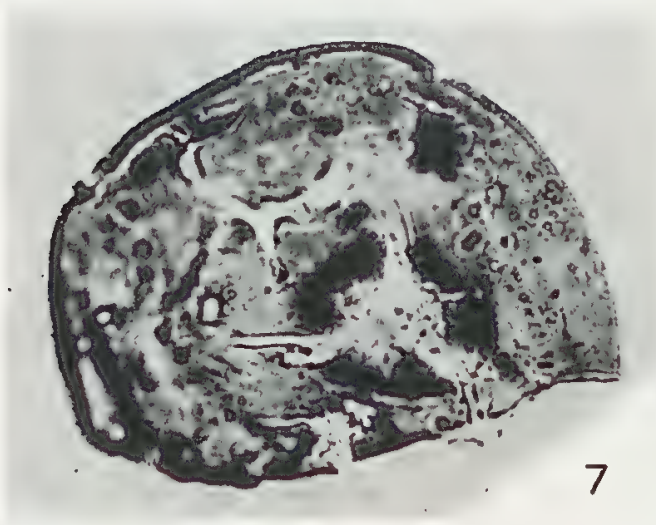

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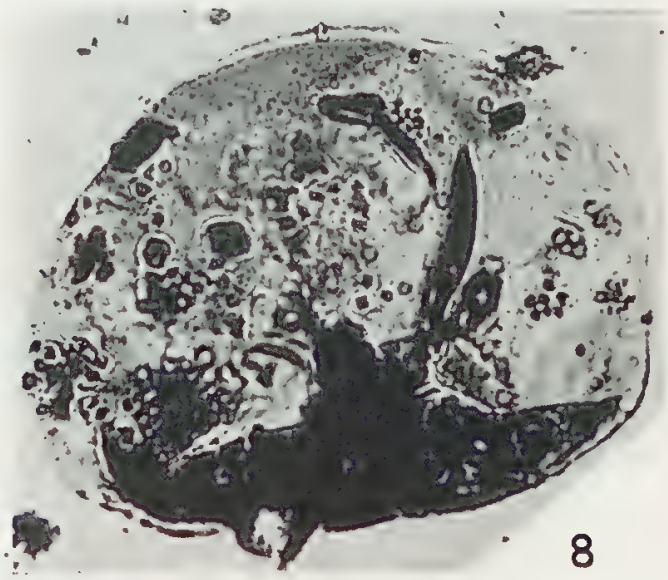

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PLATE 1

PLATE 2

(All photographs approximately x 1000)

Figure 1.—*Retusotriletes simplex* Naumova (Proximal focus).

Figure 2.—*Retusotriletes simplex* Naumova (Proximal focus).

Figure 3.—*Retusotriletes pychovii* Naumova (Proximal focus).

Figure 4.—*Retusotriletes tenerimedium* Tschibrickova (Proximal focus).

Figure 5.—*Retusotriletes* sp. cf. *R. devonicus* Naumova (Proximal focus).

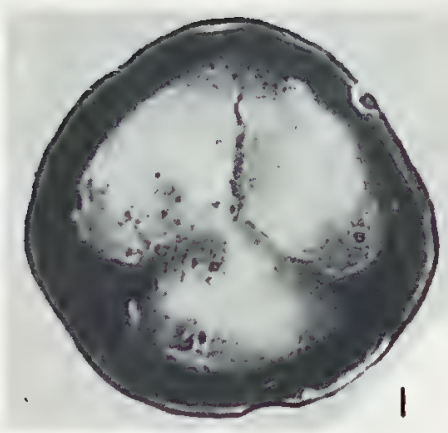
Figure 6.—*Retusotriletes* sp. cf. *R. devonicus* Naumova (Equatorial focus).

Figure 7.—*Retusotriletes* sp. cf. *R. devonicus* Naumova (Distal focus).

Figure 8.—*Granulatisporites phillipsi*, sp. nov. (Holotype).

Figure 9.—*Granulatisporites phillipsi*, sp. nov.

Figure 10.—*Granulatisporites phillipsi*, sp. nov.



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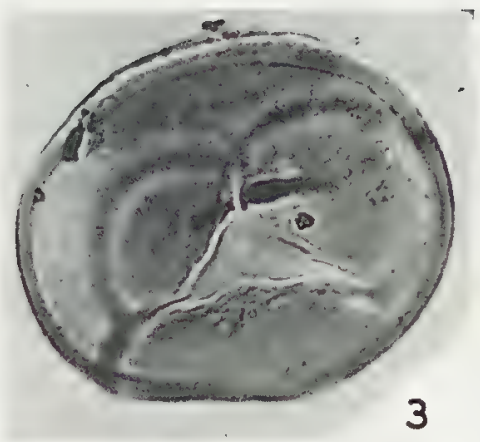

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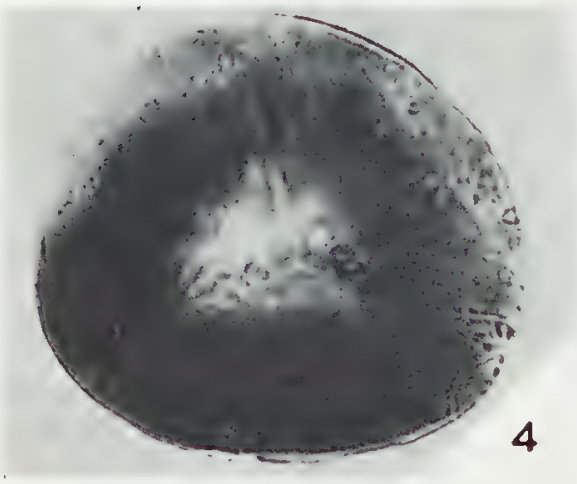

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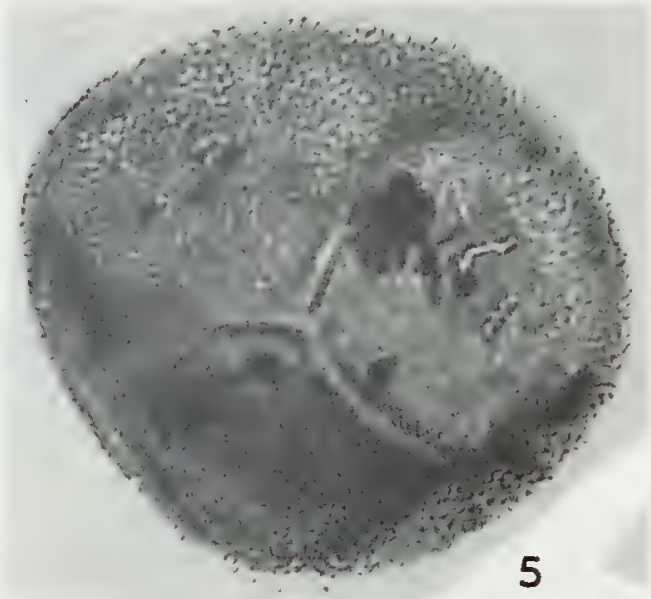

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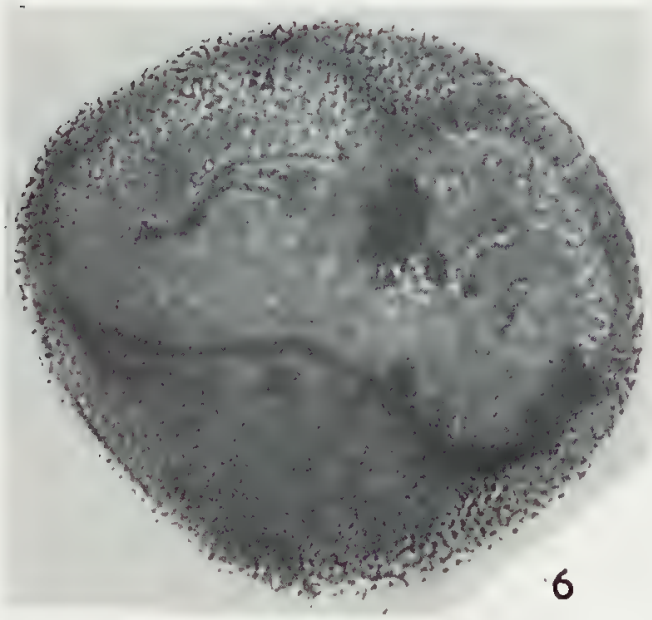

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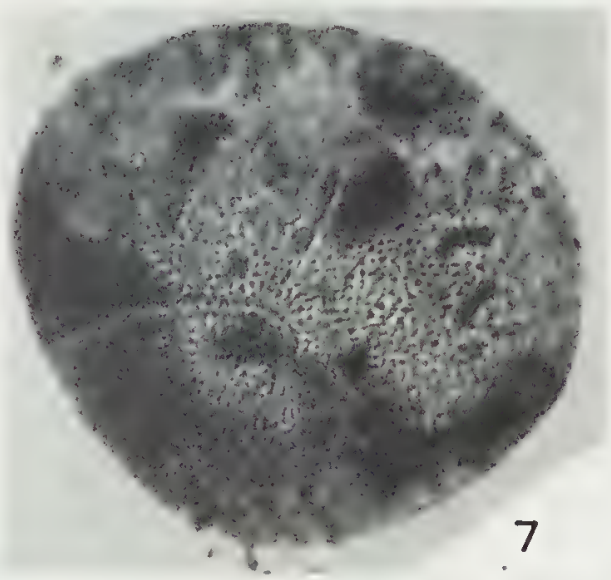

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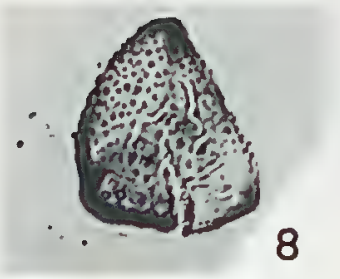

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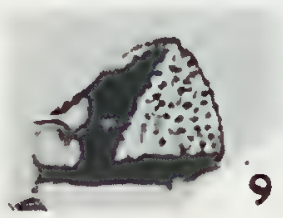

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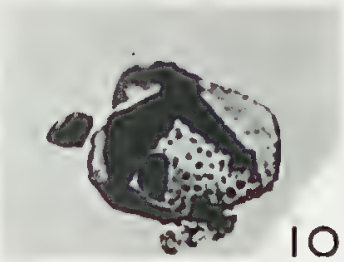

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PLATE 2

PLATE 3

(All photographs approximately x 1000)

Figure 1.—*Punctatisporites* sp.

Figure 2.—*Cyclogranisporites* sp.

Figure 3.—*Schopfites microverrucatus*, sp. nov.

Figure 4.—*Heterotriletes priscus*, sp. nov. (Holotype).

Figure 5.—*Heterotriletes priscus*, sp. nov.

Figure 6.—*Schopfites microverrucatus*, sp. nov.

Figure 7.—*Heterotriletes priscus*, sp. nov.

Figure 8.—*Schopfites microverrucatus*, sp. nov. (Holotype).

Figure 9.—*Apiculatisporis adavalensis*, sp. nov.

Figure 10.—*Apiculatisporis adavalensis*, sp. nov.

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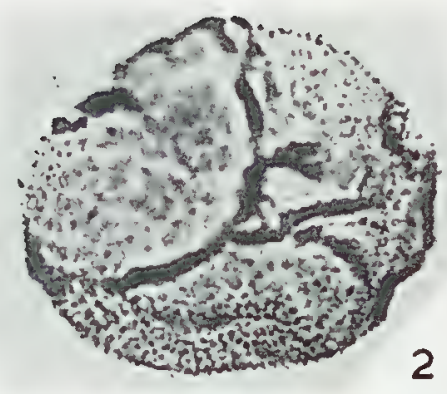
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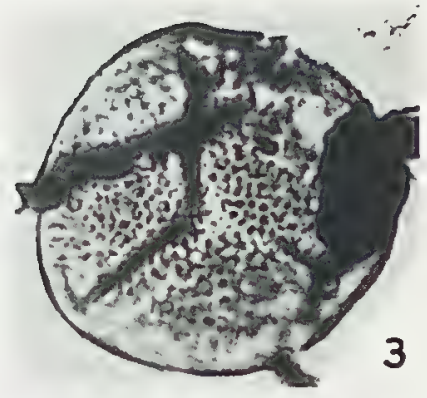
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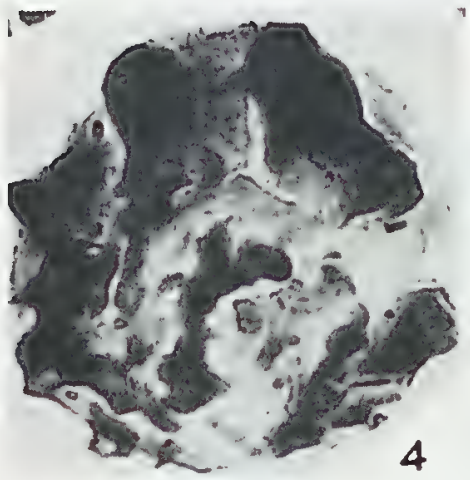
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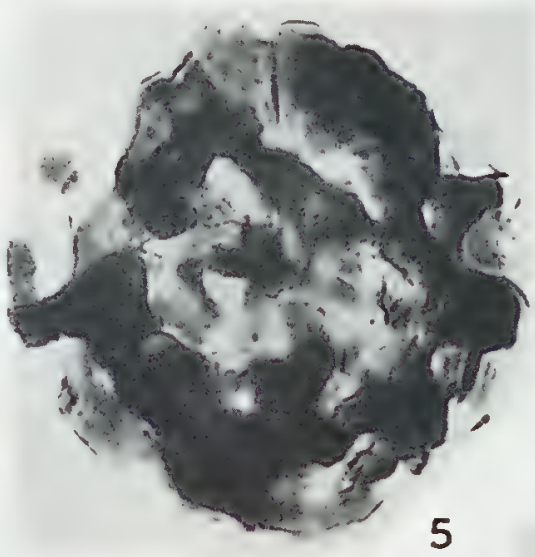
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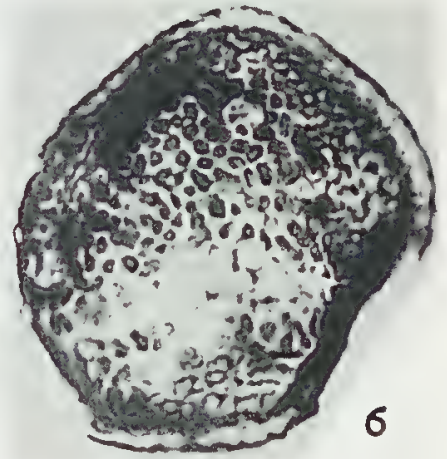
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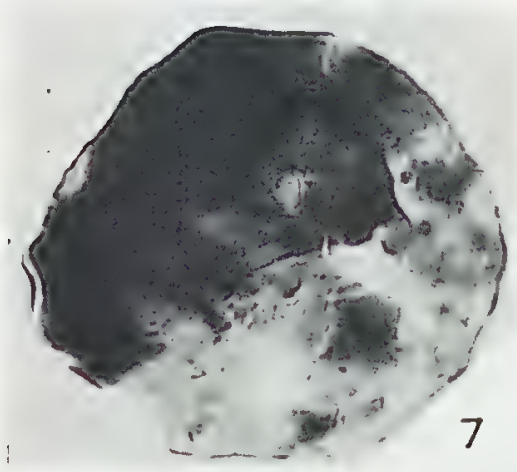
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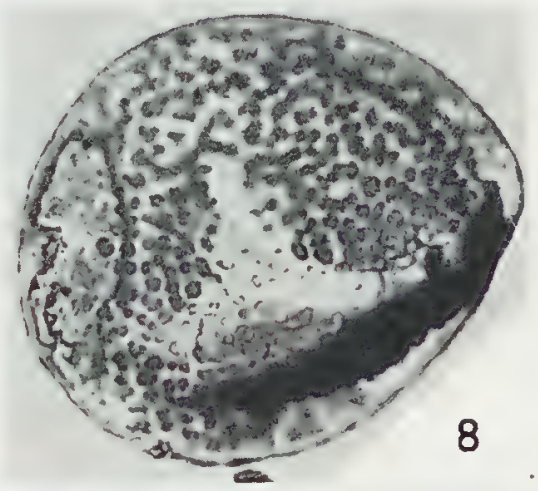
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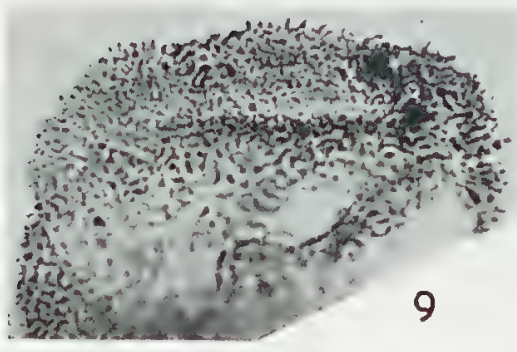
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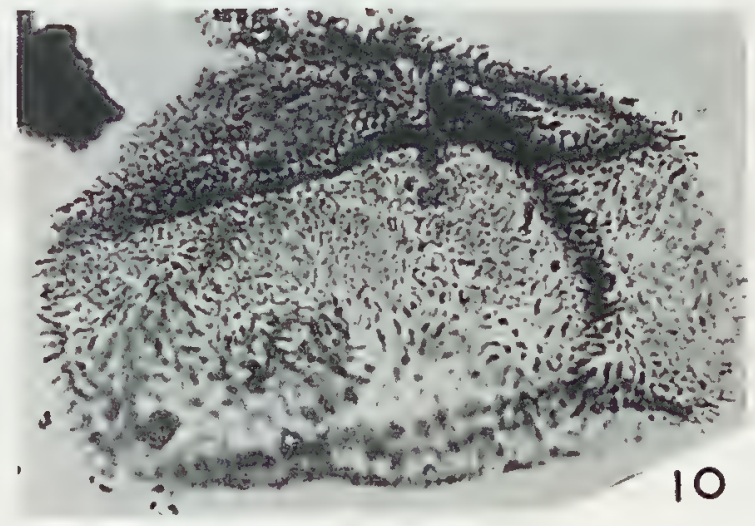
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PLATE 3

PLATE 4

Figure 1.—*Apiculatisporis adavalensis*, sp. nov. (Holotype) x 1000.

Figure 2.—*Apiculatisporis adavalensis*, sp. nov. x 1000.

Figure 3.—*Dibolisporites* sp. (Proximal focus) x 630.

Figure 4.—*Dibolisporites* sp. (Distal focus) x 630.

Figure 5.—Biform projection on specimen in Figures 3 and 4. x 1000.

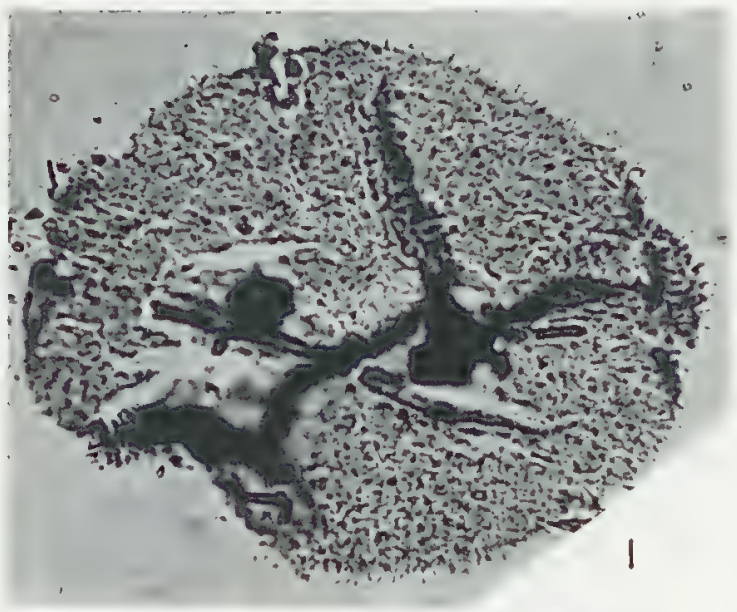
Figure 6.—Biform projection on specimen in Figure 10. x 1000.

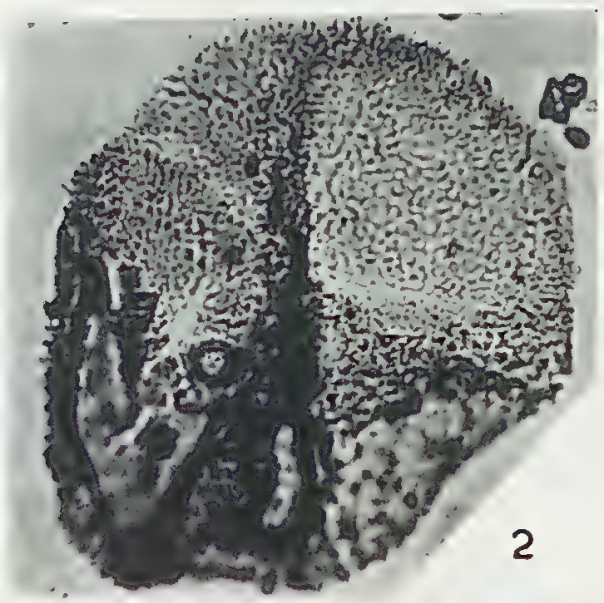
Figure 7.—Biform projection on specimen in Figure 10. x 1000.

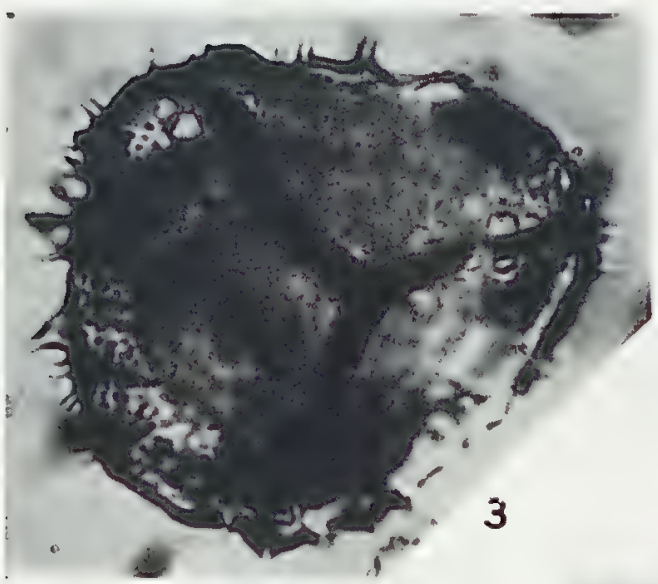
Figure 8.—Biform projection on specimen in Figures 3 and 4. x 1000.

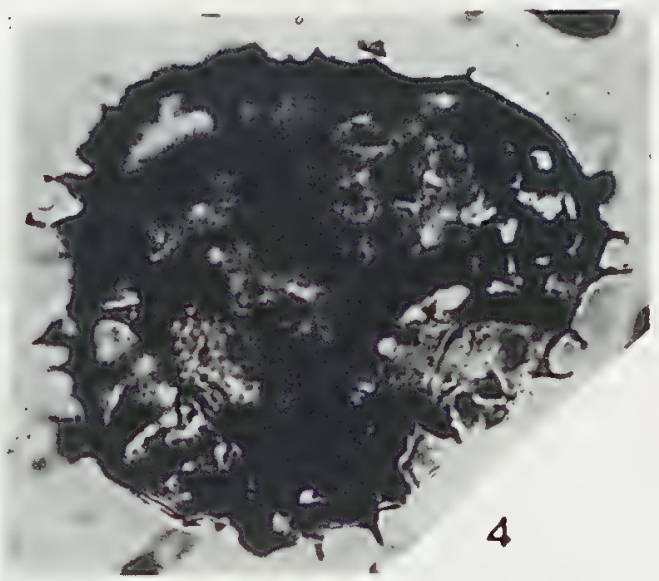
Figure 9.—*Dibolisporites* sp. x 630.

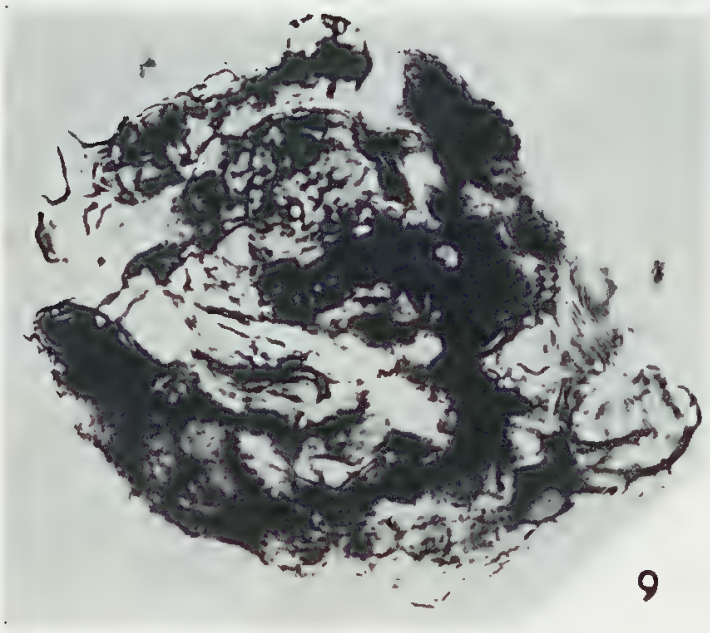
Figure 10.—Gen. Nov. A. x 630.











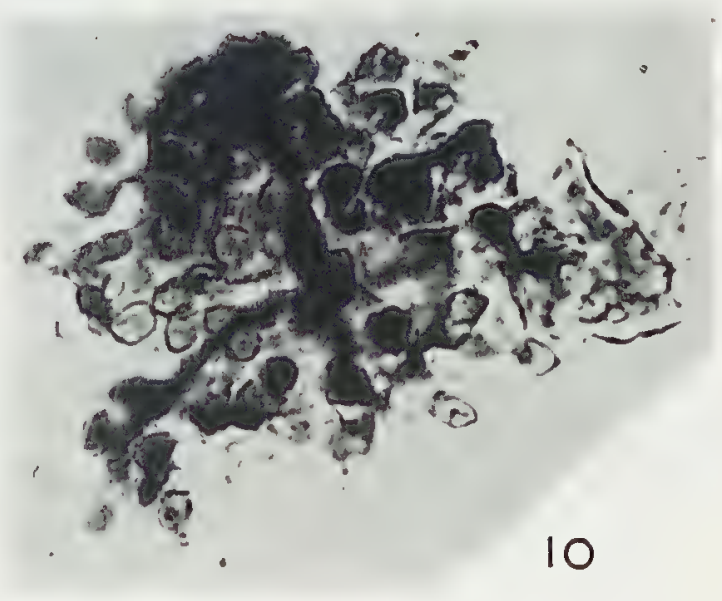


PLATE 4

PLATE 5

Figure 1.—*Hystricosporites richardsoni*, sp. nov. (Holotype) x 400.

Figure 2.—*Hystricosporites richardsoni*, sp. nov. x 400.

Figure 3.—Spine of *Hystricosporites* sp. A x 1000.

Figure 4.—Spine on specimen in Figure 5. x 1000.

Figure 5.—*Hystricosporites* sp. A. x 400.

Figure 6.—Spine on specimen in Figure 1. x 1000.

Figure 7.—Spine of *Hystricosporites richardsoni*, sp. nov. x 1000.

Figure 8.—Spine on specimen in Figure 5. x 1000.

Figure 9.—*Verrucosisporites pulvinatus*, sp. nov. (Holotype, proximal focus). x 1000.

Figure 10.—*Verrucosisporites pulvinatus*, sp. nov. (Holotype, distal focus). x 1000.

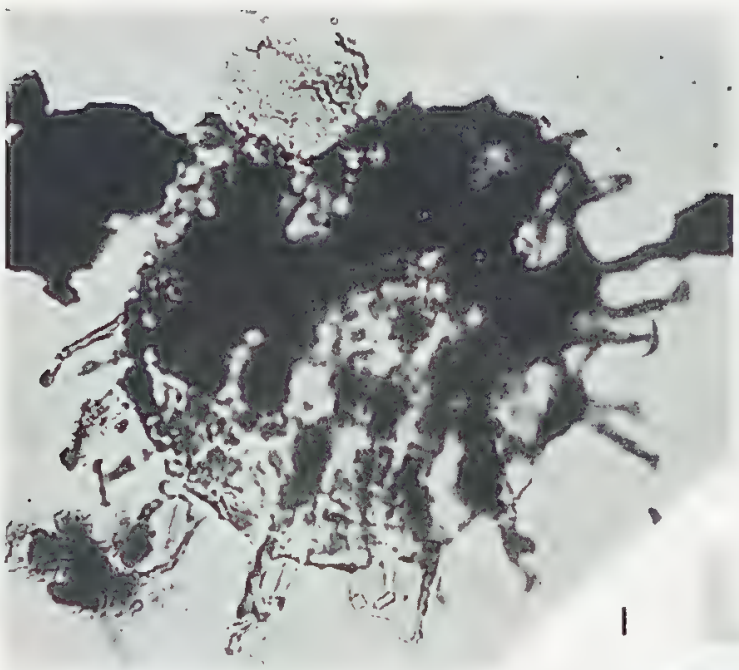
Figure 11.—*Verrucosisporites pulvinatus*, sp. nov. (Distal focus). x 1000.

Figure 12.—*Dictyotriletes australis*, sp. nov. (Holotype, proximal focus). x 1000.

Figure 13.—*Dictyotriletes australis*, sp. nov. (Holotype, distal focus). x 1000.

Figure 14.—*Dictyotriletes australis*, sp. nov. (Distal focus). x 1000.

Figure 15.—*Dictyotriletes australis*, sp. nov. (Distal focus). x 1000.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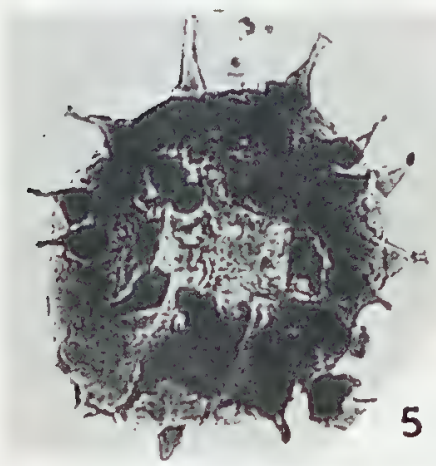
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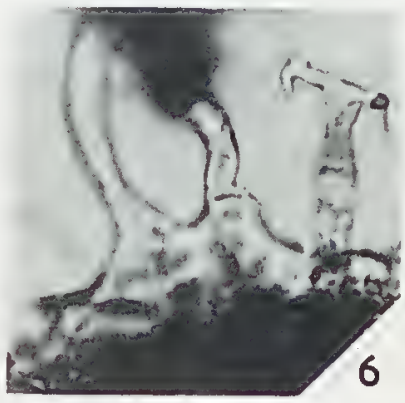
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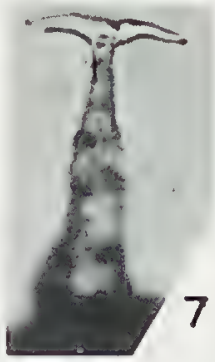
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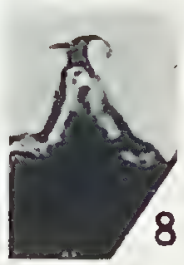
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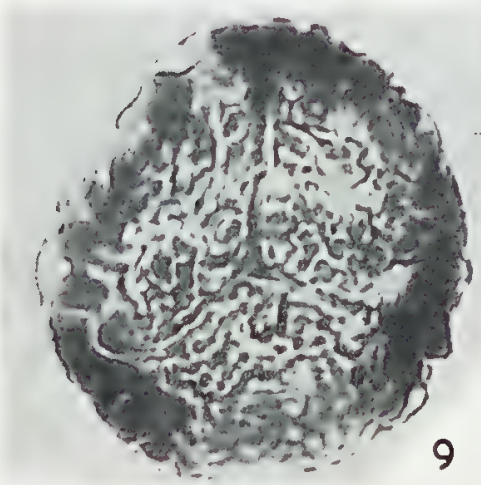
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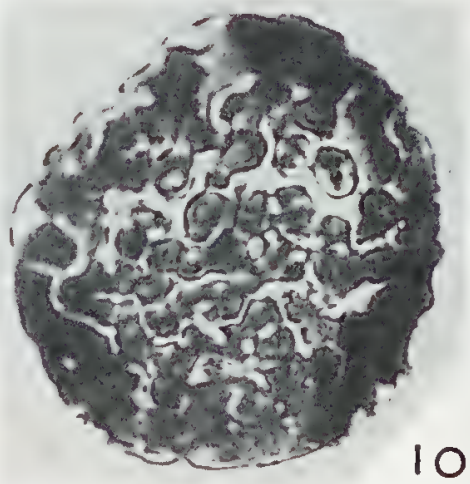
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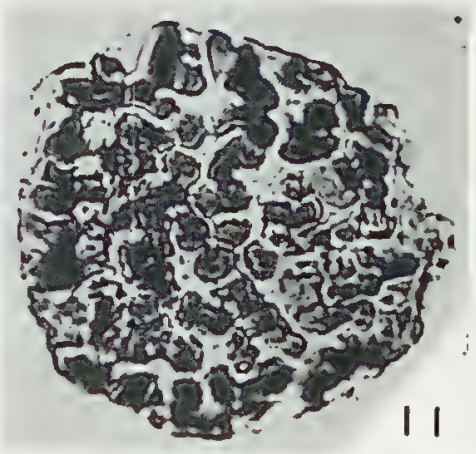
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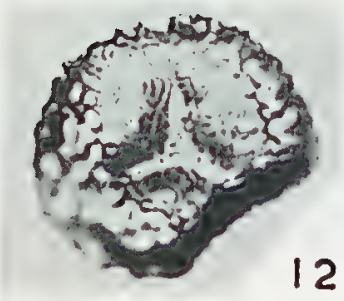
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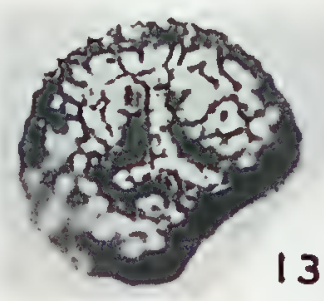
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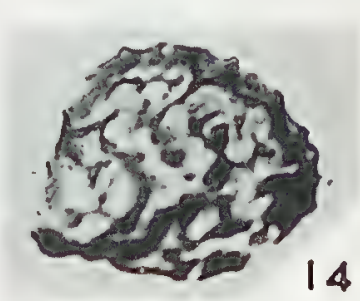
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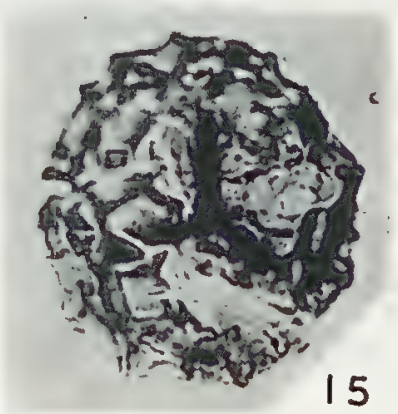
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PLATE 5

PLATE 6

Figure 1.—*Brochotriletes* sp. x 1000.

Figure 2.—*Chomotriletes* sp. x 1000.

Figure 3.—*Emphanisporites* sp. x 1000.

Figure 4.—*Densosporites atavus*, sp. nov. x 1000.

Figure 5.—*Densosporites atavus*, sp. nov. (Holotype, exposed for central area). x 1000.

Figure 6.—*Densosporites atavus*, sp. nov. (Holotype, exposed for ornament on cingulum). x 1000.

Figure 7.—*Densosporites atavus*, sp. nov. x 1000.

Figure 8.—*Archaeozonotriletes variabilis* Naumova. x 1000.

Figure 9.—*Archaeozonotriletes variabilis* Naumova. x 1000.

Figure 10.—*Endosporites* sp. cf. *E. micromanifestus* Hacquebard. x 630.

Figure 11.—*Stenozonotriletes simplex* Naumova. x 1000.

Figure 12.—*Stenozonotriletes simplex* Naumova. x 1000.

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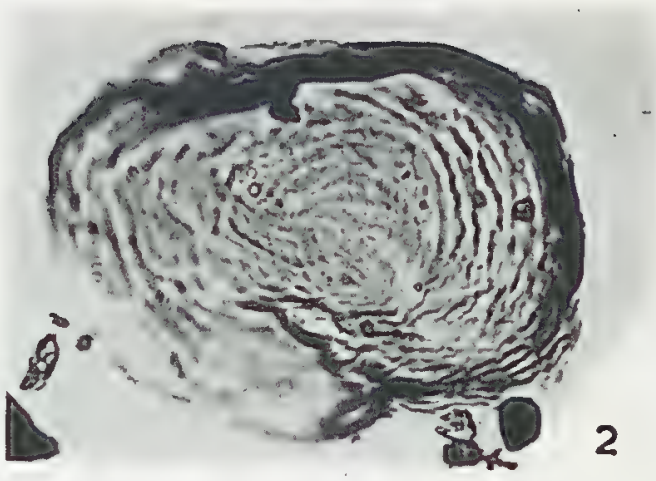
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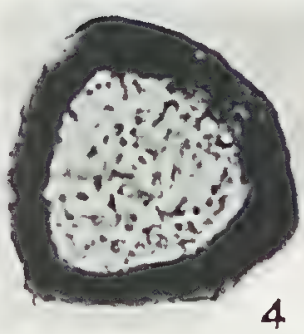
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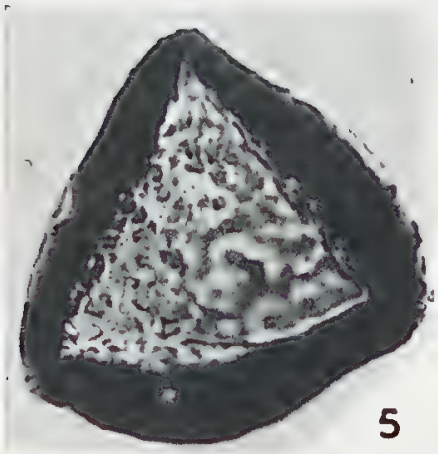
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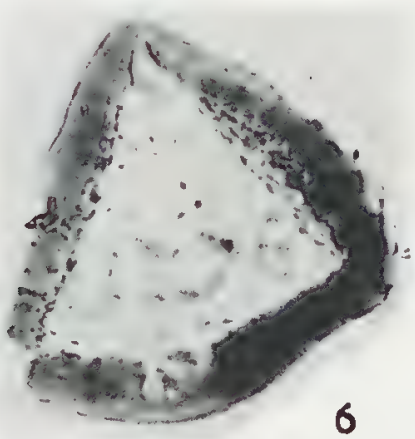
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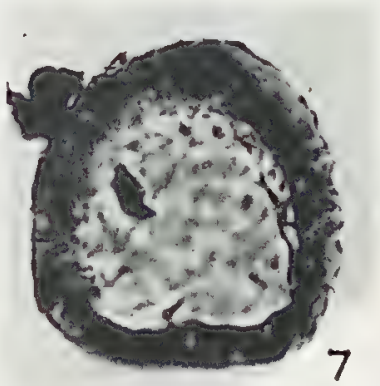
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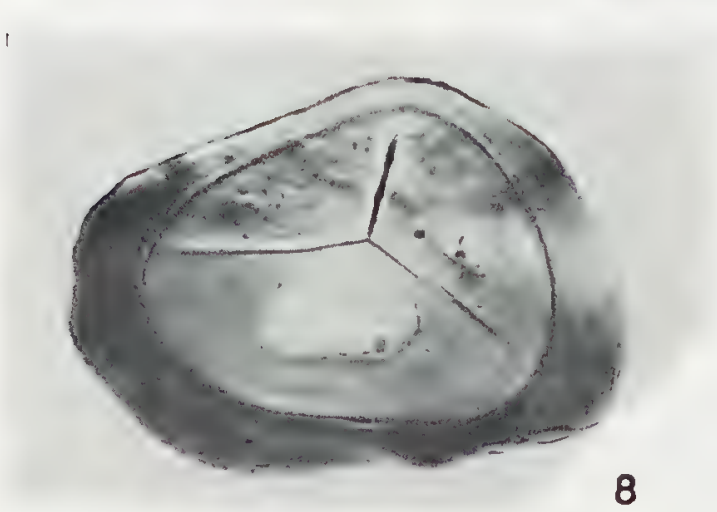
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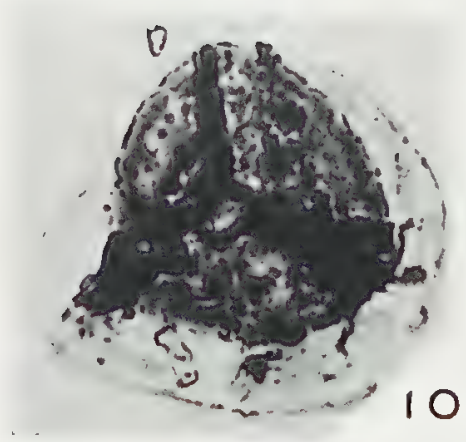
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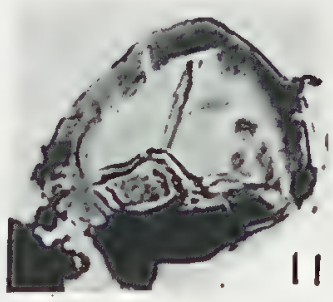
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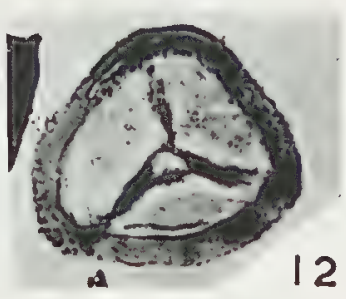
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PLATE 6

PLATE 7

Figure 1.—*Endosporites* sp. cf. *E. macromanifestus* Hacquebard. x 630.

Figure 2.—*Endosporites gilmorensis*, sp. nov. (Holotype). x 630.

Figure 3.—*Endosporites gilmorensis*, sp. nov. x 630.

Figure 4.—*Ancyrospora parva*, sp. nov. (Holotype). x 400.

Figure 5.—*Ancyrospora parva*, sp. nov. x 400.

Figure 6.—*Ancyrospora parva*, sp. nov. x 400.

Figure 7.—*Ancyrospora parva*, sp. nov. x 400.

Figure 8.—*Ancyrospora parva*, sp. nov. x 400.

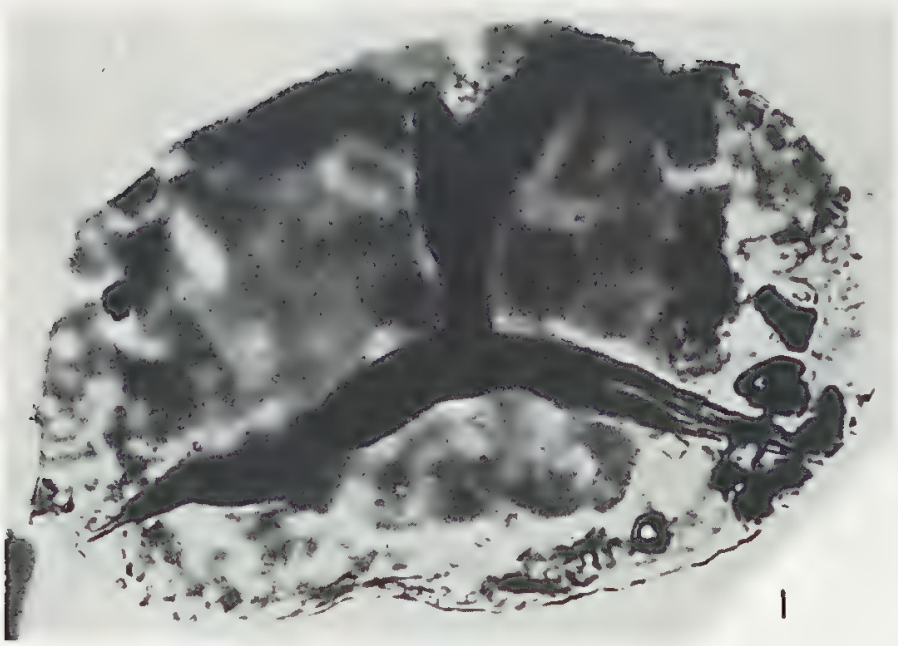
Figure 9.—Spine on specimen in Figure 4. x 1000.

Figure 10.—Spine on specimen in Figure 4. x 1000.

Figure 11.—Broken bifid spine on specimen in Figure 5. x 1000.

Figure 12.—Broken bifid spine on specimen in Figure 6. x 1000.

Figure 13.—Central portion of specimen in Figure 4. x 1000.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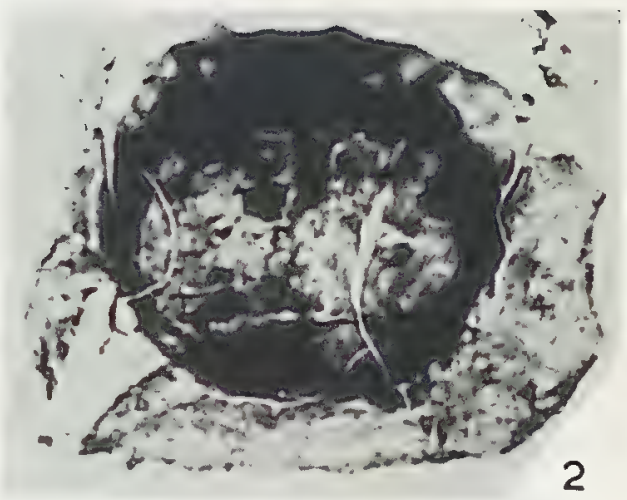
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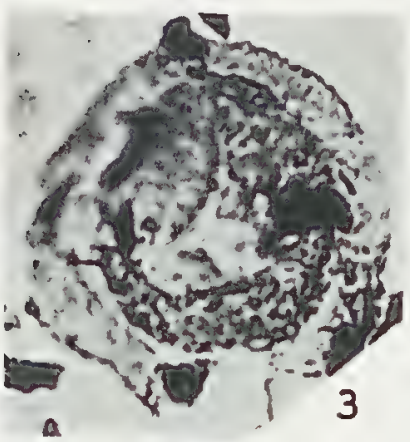
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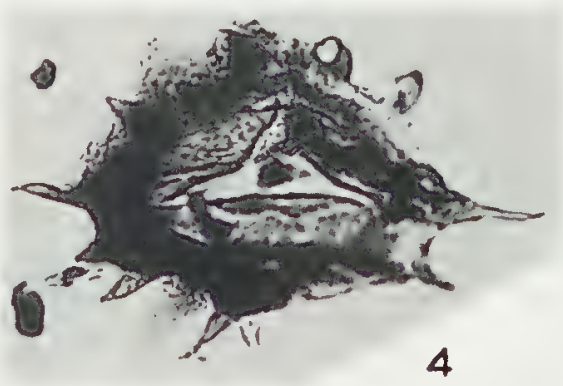
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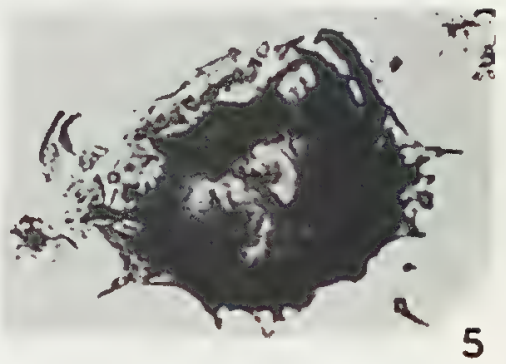
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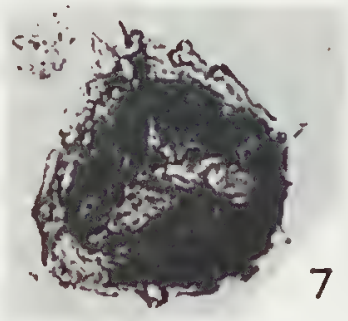
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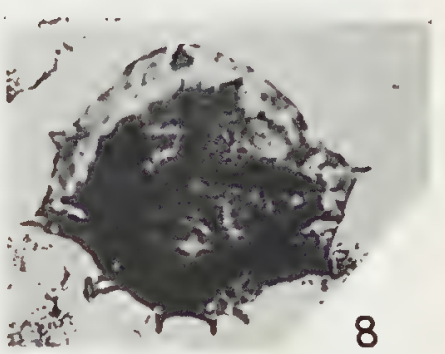
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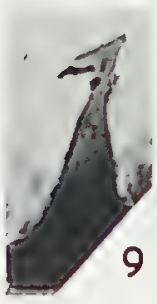
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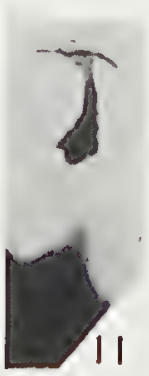
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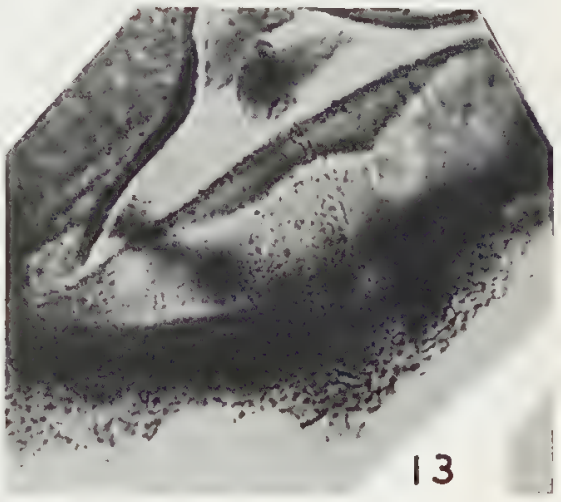
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PLATE 7

PLATE 8

Figure 1.—*Ancyrospora* sp. A. x 400.

Figure 2.—*Ancyrospora* sp. A. x 400.

Figure 3.—*Ancyrospora* sp. A. x 400.

Figure 4.—Group of verrucae on specimen in Figure 2. x 1000.

Figure 5.—Group of verrucae on specimen in Figure 1. x 1000.

Figure 6.—Bifid spine on specimen in Figure 2. x 1000.

Figure 7.—Bifid spine on specimen in Figure 3. x 1000.

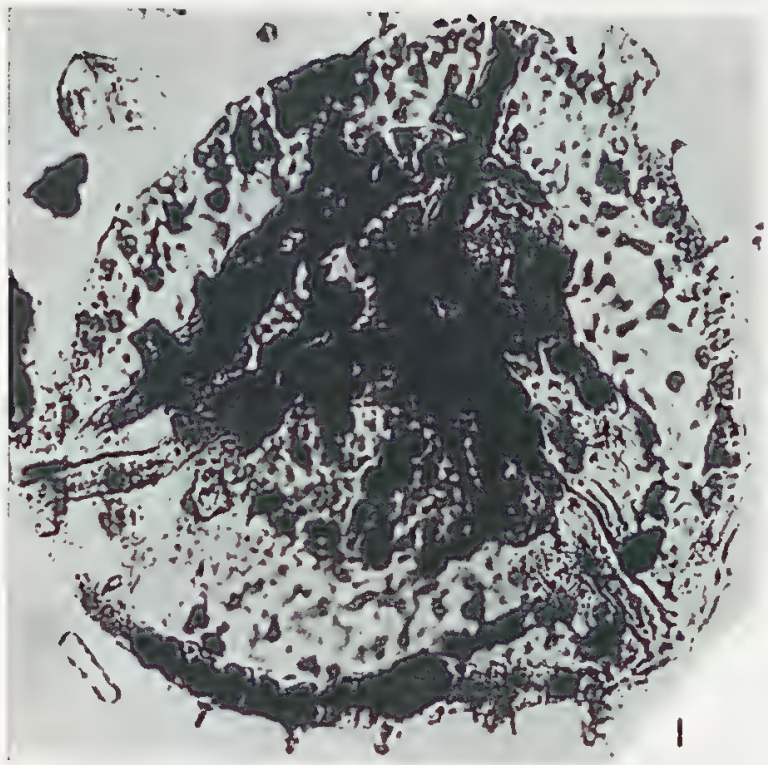
Figure 8.—Bifid spine on specimen in Figure 1. x 1000.

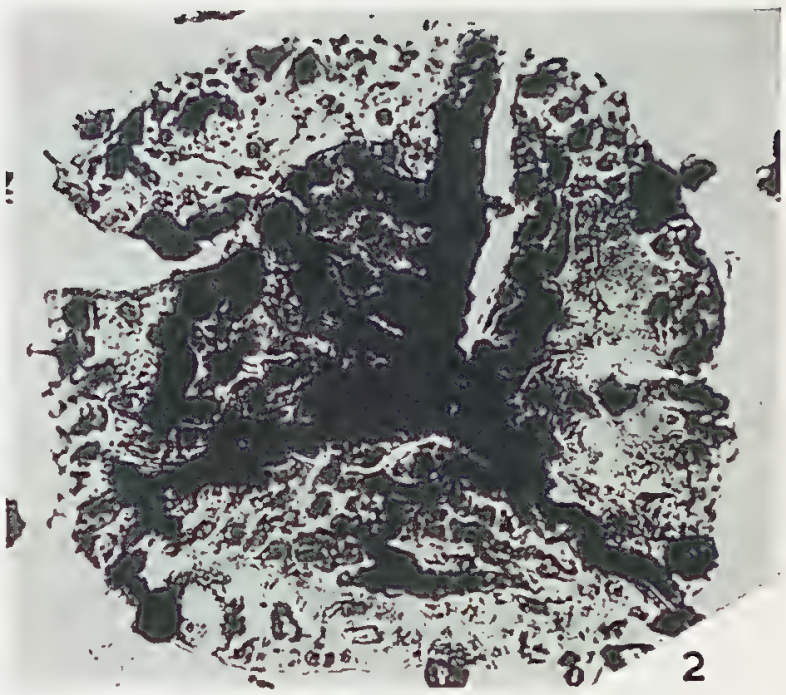
Figure 9.—Bifid spine on specimen in Figure 12. x 1000.

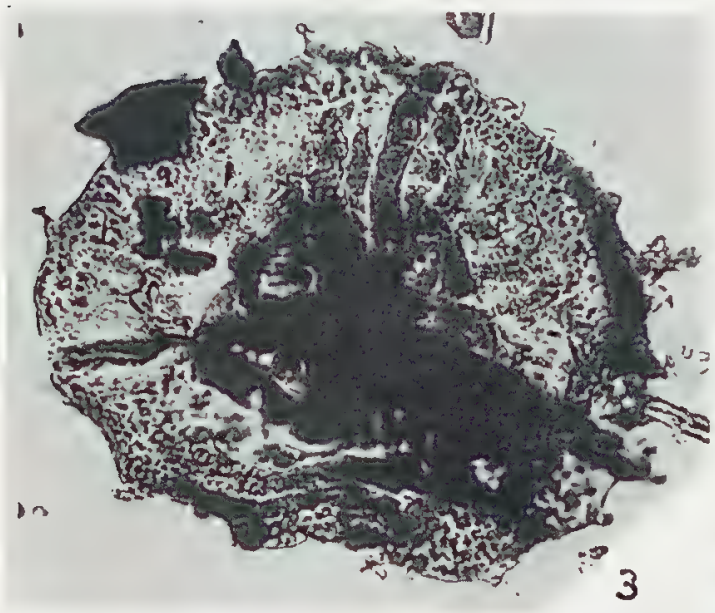
Figure 10.—*Ancyrospora* sp. cf. *A. ancyrea* (Eisenack) Richardson. x 400.

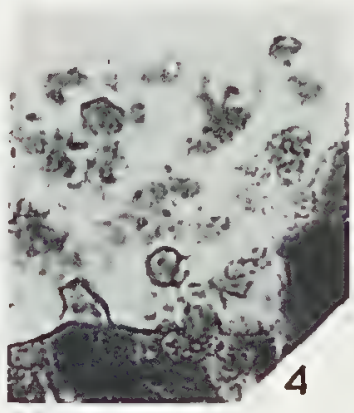
Figure 11.—Bifid spine on specimen in Figure 10. x 1000.

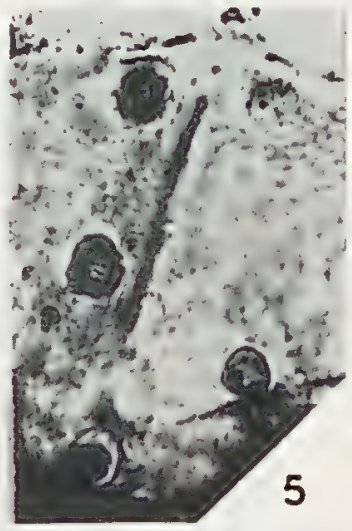
Figure 12.—*Ancyrospora* sp. cf. *A. ancyrea* (Eisenack) Richardson. x 400.

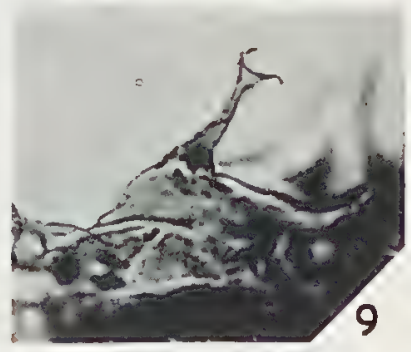


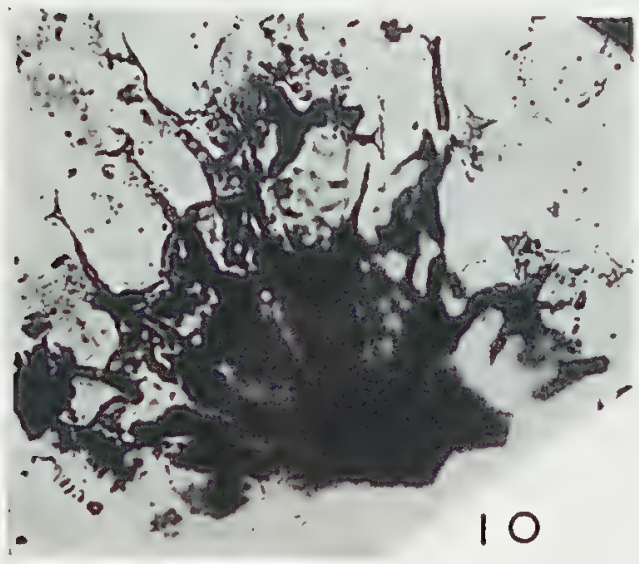












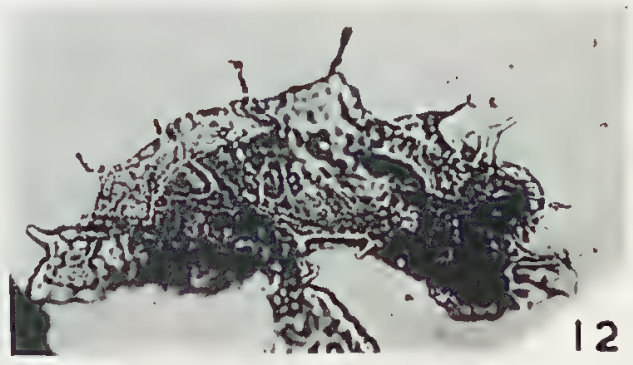


PLATE 8

PLATE 9

Figure 1.—*Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson (Proximal focus). x 400.

Figure 2.—*Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson. Portion of specimen showing sculpture of exoexine. x 1000.

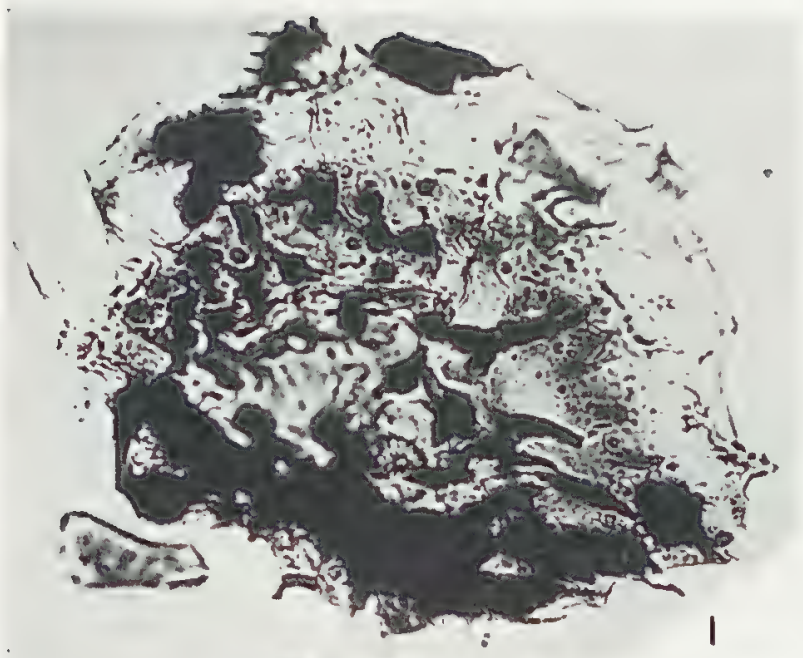
Figure 3.—*Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson. Portion of specimen showing spines. x 1000.

Figure 4.—*Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson. (Distal focus). x 400.

Figure 5.—Spine on specimen in Figure 7. x 1000.

Figure 6.—*Spinozonotriletes* sp. cf. *S. naumovii* (Kedo) Richardson. (Equatorial focus). x 400.

Figure 7.—*Ancyrospora* sp. x 400.



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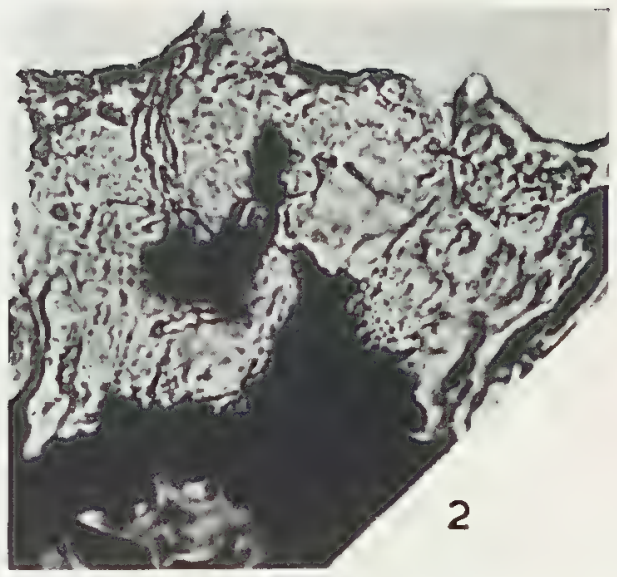

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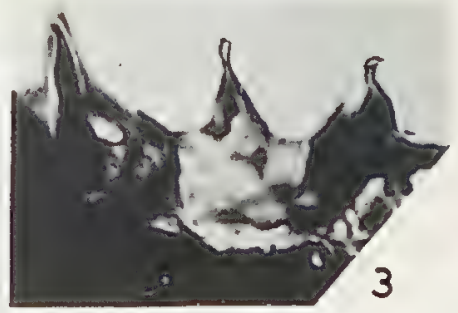

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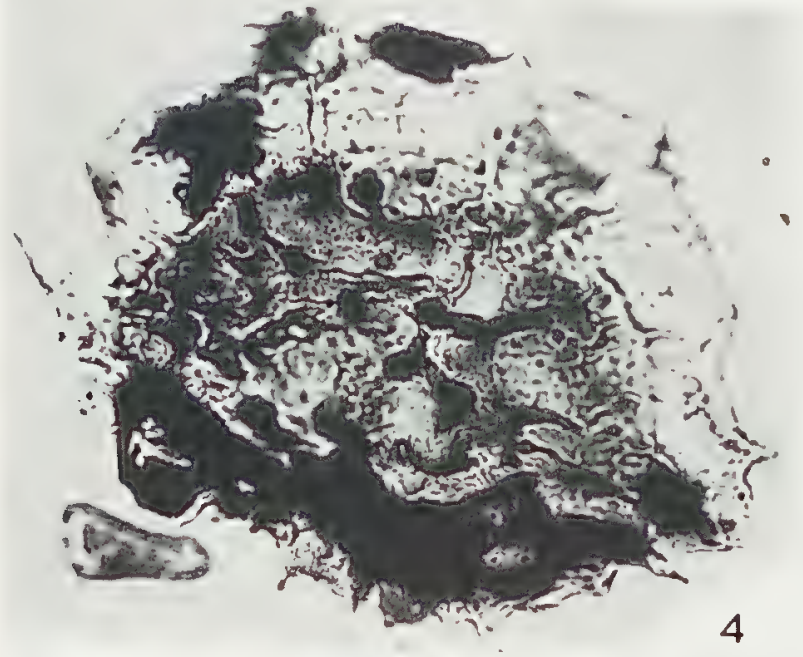

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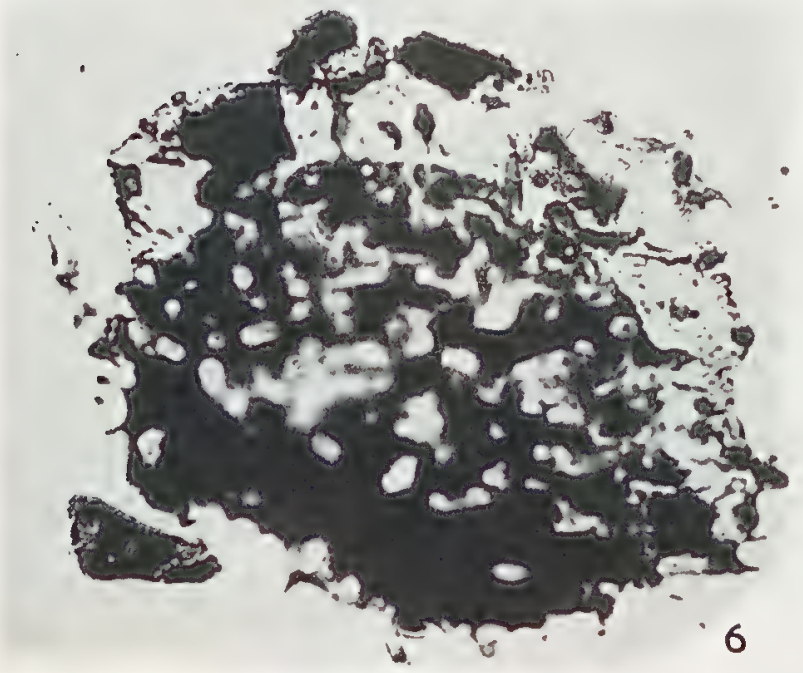

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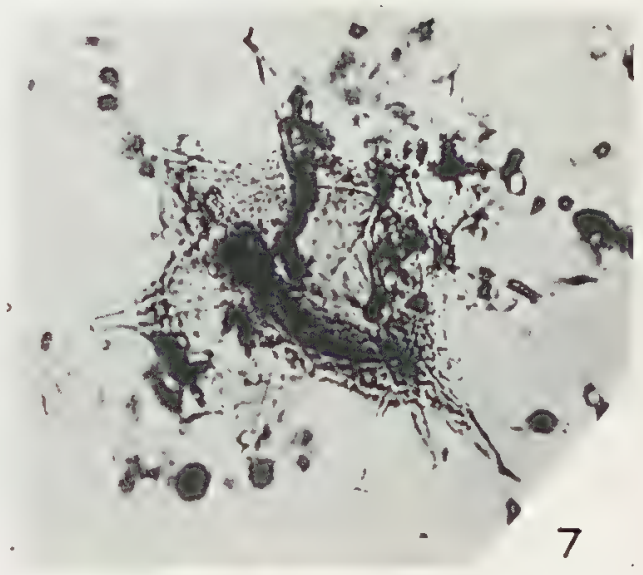

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PLATE 9

PLATE 10

(All photographs approximately x 1000)

Figure 1.—*Geminospora lemurata* Balme (Equatorial focus).

Figure 2.—*Geminospora lemurata* Balme (Proximal focus).

Figure 3.—*Geminospora lemurata* Balme (Distal focus).

Figure 4.—*Geminospora micrograna*, sp. nov. (Distal focus).

Figure 5.—*Geminospora micrograna*, sp. nov. (Holotype, proximal focus).

Figure 6.—*Geminospora micrograna*, sp. nov. (Holotype, distal focus).

Figure 7.—*Geminospora lemurata* Balme (Proximal focus).

Figure 8.—*Geminospora lemurata* Balme (Distal focus).

Figure 9.—*Laevigatosporites* sp.

Figure 10.—*Geminospora lemurata* Balme (Proximal focus).

Figure 11.—*Geminospora lemurata* Balme (Equatorial focus).

Figure 12.—*Latosporites* sp.

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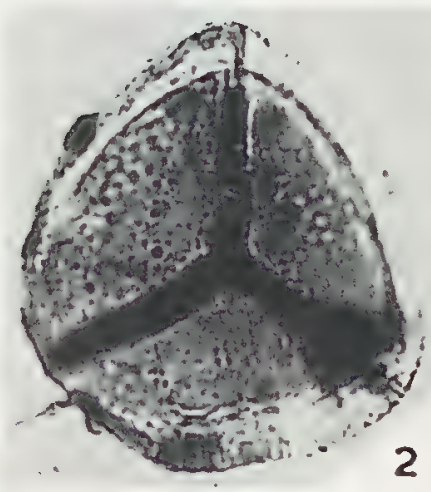
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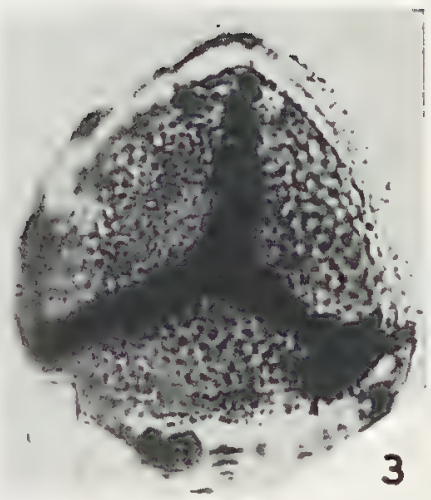
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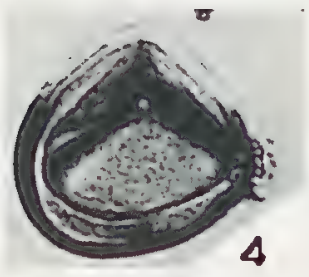
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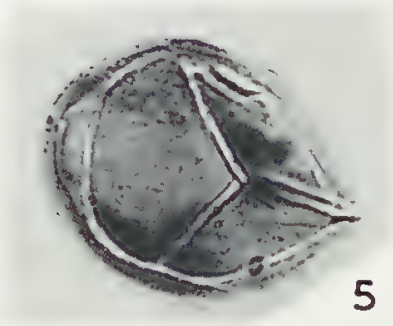
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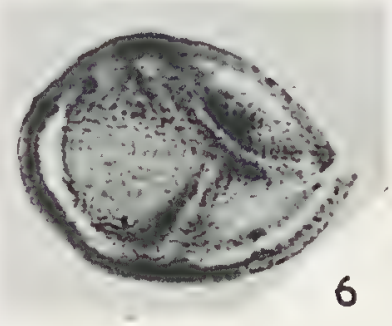
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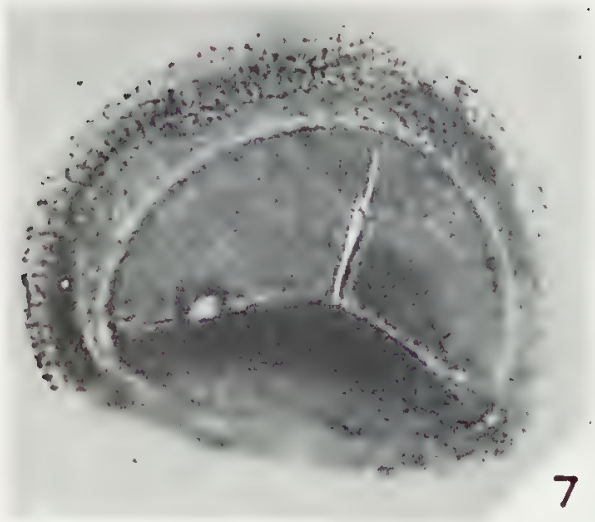
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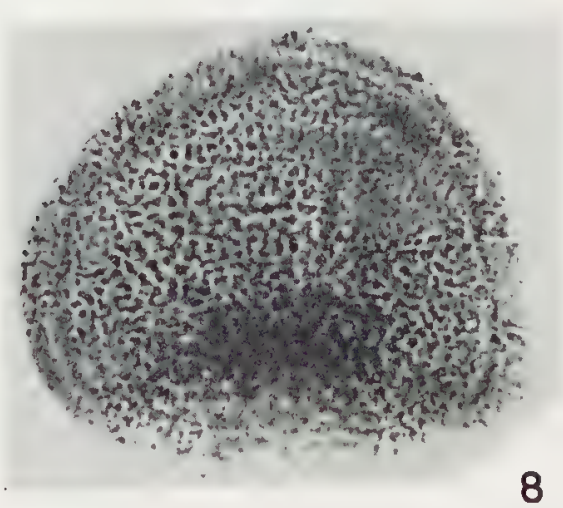
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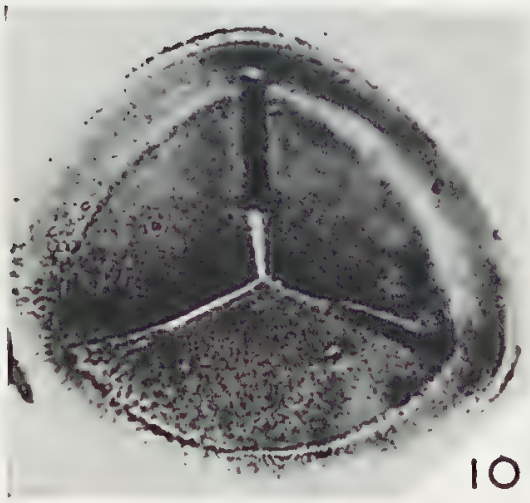
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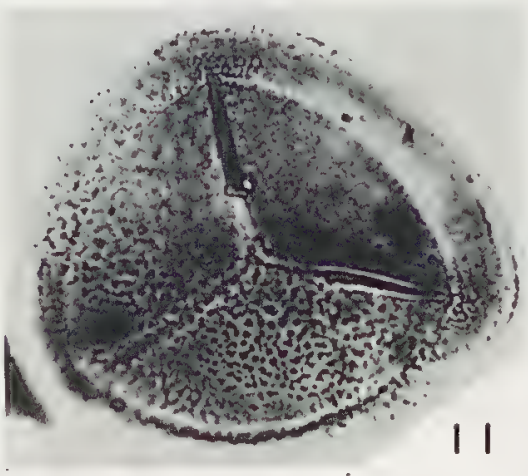
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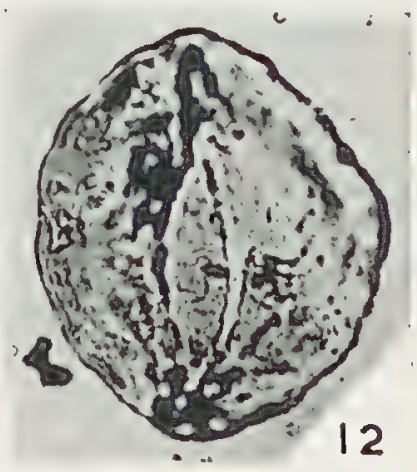
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PLATE 10

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FIG. 2 MICROFLORAL DISTRIBUTION DIAGRAM — PHILLIPS SUNRAY ETONVALE Nº1 WELL

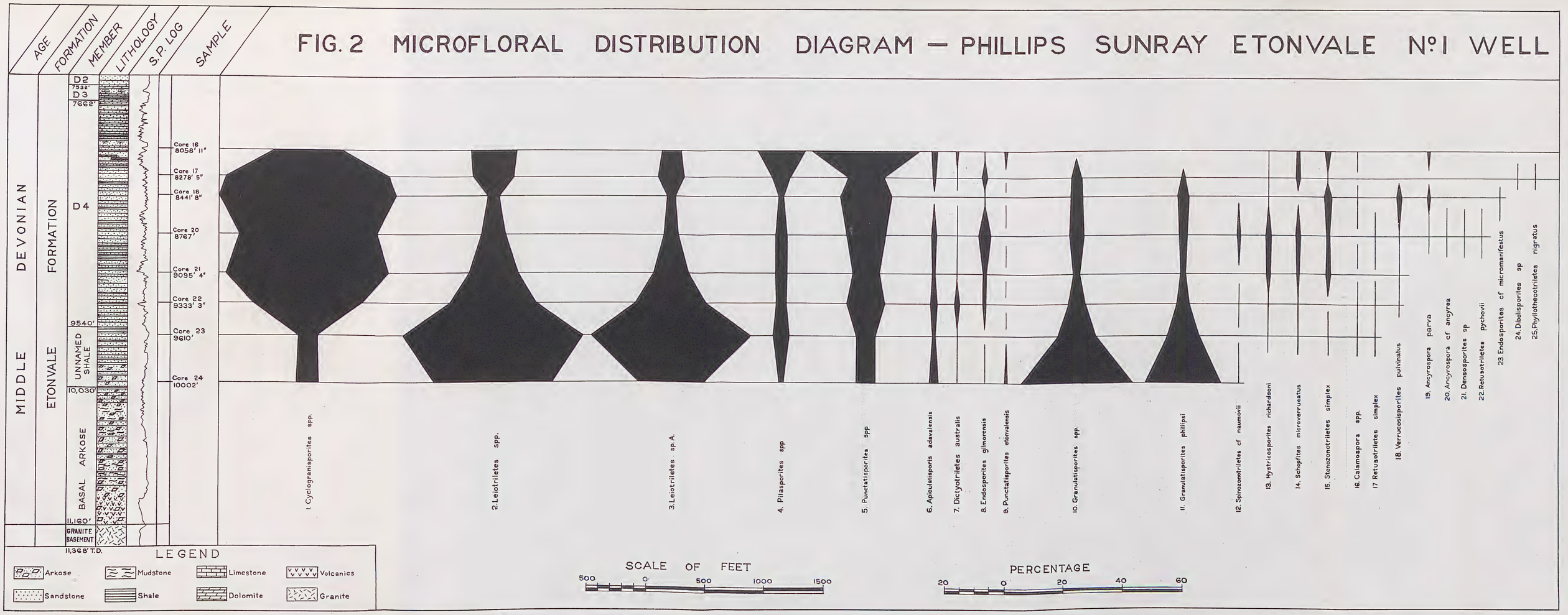

FIG. 3 MICROFLORAL DISTRIBUTION DIAGRAM — PHILLIPS SUNRAY GUMBARDO Nº1 WELL

AGE | FORMATION | MEMBER | LITHOLOGY | S.P. LOG | SAMPLE

DEVONIAN

MIDDLE DEVONIAN

BUCKABIE FORMATION

ETONVALE FORMATION

GUMBARDO FORMATION

7700′

D1

8084′

D2

8970′

D3

9144′

D4

10393′

Core 5 8336′1″

Core 6 8705′0″

Core 10 9561′5″

Core 11 9896′0″

Core 12 10318′0″

LEGEND

Limestone
Dolomite
Conglomerate
Sandstone
Siltstone
Claystone
Shale
Volcanics

SCALE OF FEET

500 0 500 1000 1500

PERCENTAGE

20 0 20 40 60

c f

1. Cyclogranisporites spp.
2. Endosporites gilmorensis
3. Granulatisporites spp.
4. Leiotriletes spp.
5. Leiotriletes sp. A.
6. Pilasporites spp.
7. Punctatisporites spp.
8. Apiculatisporis adavalensis
9. Granulatisporites phillipsi
10. Dictyotriletes australis
11. Schopfites microverrucatus
12. Punctatisporites etonvalensis
13. Retusotriletes simplex
14. Retusotriletes tenerimedium
15. Spinozonotriletes cf. naumovii
16. Calamospora spp.
17. Phyllothecotriletes nigratus
18. Ancyrospora spp.
19. Ancyrospora parva
20. Retusotriletes cf. devonicus
21. Densosporites afavus
22. Dibolisporites sp.
23. Endosporites cf. micromanifestus
24. Heterotriletes priscus
25. Hystricosporites sp. A.
26. Laeviqatosporites sp.
27. Gen. nov. A.
28. Archaeozonotriletes variabilis
29. Chomotriletes sp.
30. Emphanisporites sp.
31. Geminospora lemurata
32. Geminospora micrograna
33. Retusotriletes pychovii
34. Stenozonotriletes simplex

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QUEENSLAND
DEPARTMENT OF MINES

GEOLOGICAL SURVEY OF QUEENSLAND
(A. K. Denmead, M.C., Chief Government Geologist)

PUBLICATION No. 335

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by
R. W. DAY, B.Sc. (Hons)
(Australian National University, Canberra)

BRISBANE
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1981

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1967

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MARINE LOWER CRETACEOUS FOSSILS FROM THE MINMI MEMBER, BLYTHESDALE FORMATION, ROMA-WALLUMBILLA AREA

by R. W. DAY, B.Sc.(Hons)
Geology Department, Australian National University

ABSTRACT

A fauna of early Cretaceous (probably early Aptian) age is described from the Minmi Member, the basal unit of the marine Cretaceous sequence in this area of the Surat Basin. Systematic descriptions of 25 species, comprising 20 bivalves, 3 gastropods, 1 belemnite, and 1 inarticulate brachiopod, are presented. One new genus and six new species are recognised, and one species is renamed. New bivalve species are *Maranoana etheridgei* gen. & sp. nov., *"Nuculana" minmiensis* sp. nov., *Tancredia* (*Corburella*) *trigoniformis* sp. nov., *Cyrenopsis balli* sp. nov., *Meleagrinella woodsi* sp. nov., and *Panopea rugosa* Moore is renamed *Panopea moorei* nom. nov. A new gastropod species *Neritopsis minmiensis* sp. nov. is also erected. Closest faunal affinity is with the overlying Aptian Roma Formation. This indicates a probable early Aptian age for the Minmi Member. The fauna occurs largely as a thanatocoenose or transported fossil assemblage, and probably comprises species derived from a number of littoral and near coastal shallow water communities.

In addition, the nature and relationships of the Aptian transgressions in the Surat and Eromanga Basins are considered, and the possibility of an Aptian seaway connecting the Surat and Maryborough Basins is discussed.

INTRODUCTION

The Minmi Member, defined by Day (1964), comprises the 50-70 ft of marine sediments at the top of the Blythesdale Formation in the Roma–Wallumbilla area of the Surat Basin. They mark, with the possible exception of the Jurassic "Bundamba Group" which has yielded hystricospheres (Evans, 1962), the first marine transgression into this area since Permian times. [A marine fauna has since been found in the underlying Nullawurt Member in the Mitchell area (Day, 1967).]

Work in the Roma–Wallumbilla area was initiated in 1959 as a post-graduate honours project, within the Department of Geology and Mineralogy, University of Queensland. Subsequent to my joining the staff of the Geological Survey of Queensland in 1961, the project was expanded and collections housed in that institution were included in the study. The work was completed at the Department of Geology, Australian National University.

Grateful acknowledgment is made of the assistance to the project rendered by Professor D. Hill, Department of Geology and Mineralogy, University of Queensland, Mr. A. K. Denmead, Chief Government Geologist, Geological Survey of Queensland, Mr. J. T. Woods, Queensland Museum, Dr. J. M. Dickins, Bureau of Mineral Resources, Dr. N. H. Ludbrook, South Australian Mines Department, Professor D. A. Brown and Dr. K. S. W. Campbell, both of Department of Geology, Australian National University.

Collections from 43 localities were studied and preliminary determinations were tabulated by Day (1964). The fossil localities are marked on the map accompanying that publication and are listed here in an appendix. In this paper systematic descriptions of these fossils are presented. A total of 25 species are described, or which 6 are new.

The following abbreviations are used for institutions in which material is housed:—G.S.Q. Geological Survey of Queensland, Q.M. Queensland Museum; U.Q. University of Queensland Department of Geology and Mineralogy.

PREVIOUS WORK

Marine fossils have been known from the Roma–Wallumbilla area for more than 100 years (Clarke, 1862; McCoy, 1865). However, very few fossils have been described from localities within the area of outcrop of the Minmi Member.

Moore (1870, pl. 13, fig. 13) described *Tancredia plana* from "Blythesdale, fifteen miles from Wallumbilla." Unfortunately, this specimen, along with most of Moore's types, was destroyed by fire in 1882 (Etheridge Jnr., 1892, p. XVI). The form is probably conspecific with that described here as *Tancretella plana* (Moore).

Etheridge Jnr. (1892) figured fossils collected by R. L. Jack from "Minmi near Roma" as *Oxytoma ? simplex* (Moore) (pl. 24, fig. 4), *Macrocallista plana* (Moore) (pl. 27, fig. 8), *Glycimeris* sp. ind. (pl. 28, fig. 6), and *Corimya primula* (Hudleston) (pl. 28, fig. 11). He also identified *Cyprina clarkei* (Moore) from this locality. With the exception of *Oxytoma ? simplex*, no further specimens of which have been collected, these specimens are still extant in the Geological Survey collection. In this paper they are respectively referred to *Tancretella plana* (Moore), *Panopea maccoyi* (Moore), *Thracia primula* Hudleston, and *Fissilunula clarkei* (Moore). From collections made by George Sweet, Etheridge Jnr. (1892) identified *Maccoyella barklyi* (Moore) from "Blythesdale Station, between Wallumbilla and Roma," *M. corbiensis* (Moore) and *Natica variabilis* Moore from "Blythe's Creek, near Blythesdale." *Maccoyella corbiensis* has not been collected subsequently, while *Natica variabilis* is here referred to *Euspira reflecta* (Moore).

Whitehouse (1927) identified marine fossils collected by L. C. Ball from several localities within the Minmi Member. His species lists are as follows:—

Red Hill	*Coilotis lens* gen. & sp. nov. *Pecten* (*Camptonectes*) sp. *Macrocallista ? plana* (Moore) *Cyrenopsis* cf. *etheridgei* (Eth. fil) *Cyrenopsis* sp. nov. *Natica* (*Lunatia*) *variabilis* Moore *Natica ?* sp. nov.
Clerk's Creek Crossing ..	*Coilotis lens* *Thracia* cf. *wilsoni* Moore *Teredina ?* sp. *Natica* sp. ind.
State Farm Well	*Coilotis lens*
Murray's Well (80 ft) ..	*Coilotis lens*
Minka	*Lingula* cf. *subovalis* *Cyrenopsis ?* sp.
Taylor Scarp (portion 228 parish of Bungeworgorai)	*Cucullaea* sp.
Portion 13, parish of Euthulla	*Maccoyella barklyi* (Moore) *Macrocallista ? plana* (Moore)
R. 199, parish of Euthulla ..	*Macrocallista ? plana* (Moore) *Modiola eyrensis* (Eth. fil) *Nuculana elongata* (Eth.) *Panope* sp.
Portion 115v, parish of Bungeworgorai	*Maccoyella substriata* (Moore)
Portion 131v, parish of Bungeworgorai	*Maccoyella barklyi* (Moore) *Palaeomoera ?* cf. *mariaeburiensis* (Eth.) *Thracia ?* sp.

Most, but not all, of the fossils collected by L. C. Ball are still preserved in the collections of the Geological Survey of Queensland. They have been included in the present study. The species *Coilotis lens* (a *nomen nudum*), which figures so prominently in Whitehouse's lists, is described here as *Meleagrinella woodsi* sp. nov. Specimens indentified by Whitehouse as *Nuculana elongata, Cyrenopsis* sp. nov., *Maccoyella substriata Macrocallista ? plana, Modiola eyrensis* and *Natica ?* sp. nov., are described in this paper as *"Nuculana" minmiensis* sp. nov., *Cyrenopsis balli* sp. nov., *Maccoyella subangularis* Etheridge Jnr., *Tancretella plana* (Moore), *Eyrena linguloides* (Hudleston), and *Neritopsis minmiensis* sp. nov., respectively. *Cucullaea* sp., *Cyrenopsis* cf. *etheridgei, Cyrenopsis ?* sp., *Teredina ?* sp., *Panope* sp., and *Palaeomoera* cf. *mariaeburiensis* are apparently missing from Geological Survey collections.

Whitehouse (1927) also endeavoured to apply his subdivision of the "Roma Series" (Whitehouse, 1926) into stages. Details of this subdivision were not published until later. (Whitehouse, 1928).

Fossils from portion 13 and R.199 in the parish of Euthulla, he thought, were indicative of Stage II (the Australiceratan Stage). Those from portion 115v and portion 131v in the parish of Bungeworgorai he placed high in Stage II or low in Stage III (the Tropaeuman Stage). The remainder comprised what Whitehouse termed the *Coilotis lens* fauna. Whitehouse (1927) thought this fauna represented a marine stage below the "Roma Series" probably equivalent to the "Morven Bed" (Whitehouse, 1926). Later, (1930, p. 37) he named this stage the "Coilotan Stage", but modified the correlation by suggesting it might be identical with his Ancyloceratan Stage. Subsequently, Whitehouse (1946, 1955) noted that the record of the Hauterivian ammonite *Simbirskites morvenae* from Victoria Downs, Morven, was probably a spurious one, the fossil's likely provenance being North Germany. As this was the principal evidence for the existence of the "Morven Bed", Whitehouse's earlier correlation need no longer be considered.

Whitehouse (1955) referred the fauna to the "Transition Beds" of the "Blythesdale Group", without recognising any stages in this unit or the overlying Roma Formation. No stages are recognised in the present paper. The species list given by Whitehouse (1955, p. 9)—*Glyphaea arborinsularis, Maccoyella barklyi, M. corbiensis,* new genus of *Trigonia, Peratobelus australis,* and *Australiceras* cf. *jacki*—is a composite one drawn from localities in many parts of Queensland.

PALAEOECOLOGIC ASPECTS

Sediments of the Minmi Member are dominantly fine- and medium-grained glauconitic sandstones which are ripple marked and exhibit both large and small-scale cross-bedding. Minor rock types are siltstones, interlaminated siltstones and sandstones and mud-pebble conglomerates. The well-sorted nature of the sands and the associated sedimentary structures indicate deposition from moving water which was probably shallow. Very shallow, near-shore conditions are suggested by the occurrence of mud-pebble conglomerates.

Marine fossils occur in all rock types but much of the sediment is barren. Fossils appear to be restricted to horizons of limited (2–3 ft) lateral extent and thickness (2–3 in.), with only one fossiliferous horizon known from each exposure. The fossil shells are usually disarticulated and lie on bedding planes with their convex surfaces upwards, indicating pre-burial transport by currents. A notable exception is *Panopea*

maccoyi. Undisturbed shells of this species have been found orientated at right angles to bedding in an apparent life position. However, such cases are rare. At one locality (RD.99) a size-shape sorting effect is evident. The fossils approximate the sizes and shapes of mud pebbles in a 1 ft lens of mud-pebble conglomerate which extends 15 ft along the section. In the coarser grained rocks which have sets of cross beds 3–4 ft thick, shells occur singly and are very fragmentary.

Leaching is the main post-burial alteration, and most of the fossils are preserved as internal and external moulds. The process was apparently selective, as calcitic forms such as belemnites, the gastropod *Neritopsis* and the bivalves *Maccoyella* and *Meleagrinella* frequently retain their original shelly material. Fossils also retain their shells in areas of local calcareous cementation.

Evidence from sedimentary features and the condition of the fossils clearly indicates that the fauna occurs as a thanatocoenose (death assemblage) or "transported fossil assemblage" of Fagerstrom (1964). Near destructive pre-burial re-working and transport like that inferred for this fauna is a common phenomenon in modern littoral and shallow neritic environments. Sediments of the Minmi Member have previously been interpreted as very shallow water, near shore deposits (Day, 1964).

Biotic evidence supporting this interpretation is the occurrence of fossil wood in most exposures and the association of terrestrial plants with marine shells at locality L.134.

The main biotic evidence concerning the palaeoecology is obtained from the composition of the fauna. The Minmi Member has a fauna of 25 species which are, with the exception of the brachiopod *Lingula* cf. *subovalis,* entirely molluscan. Bivalves dominate the assemblage with 20 species. There are also 3 gastropod and 1 belemnite species. No ammonites have been found. Apparently the niche and/or the depositional environment were unfavourable to these organisms.

Morphologic considerations and analogies with Recent relatives allow species to be interpreted as members of infauna or epifauna. The observed mixing of the two confirms the abiotic evidence of a thanatocoenose.

The inequivalved pectinoid bivalves *Camptonectes socialis, Maccoyella barklyi, Maccoyella subangularis, Pseudavicula anomala, Meleagrinella woodsi* and *Meleagrinella* sp. which have byssal notches, and the mytilids *Eyrena linguloides, Eyrena tatei* and *Inoperna ensiformis* are all interpreted as sedentary filter feeders, living at the water-sediment interface. As such they are grouped with the sedentary epifauna. No members of the extinct pectinoid group have been observed in place and little is known of their original habitat. The abundance of mytilids is perhaps indicative of shallow water and littoral conditions, as these are favoured by living mytilids. At one locality (L.142) a cluster of specimens of *Eyrena linguloides* with closed valves occurs in a fine-grained sandstone with mud clasts.

Other species interpreted as benthonic epifauna are the gastropods *Euspira reflecta, Acteon ? hochstetteri* and *Neritopsis minmiensis.* Tracks illustrated by Day (1964, p. 13) have a median groove flanked by arched transverse ridges conspicuously like those of living ditaxic gastropods, notably predatory naticids of inter-tidal areas. Possibly they are those of the naticid *Euspira reflecta.*

Belmenites doubtfully referred to *Peratobelus australis* are probably the only free-swimming epifauna represented.

The remaining species are interpreted as infauna living below the water-sediment interface. Recent linguloid brachiopods are burrowers typically occurring in littoral environments. Possibly the habitat of *Lingula* cf. *subovalis,* which is abundant at locality RD.78, was similar. Little may be inferred from the occurrences of *"Nuculana" minmiensis,* and *Thracia primula* as living nuculanids and thraciids inhabit both shallow and deep water. *Fissilunula clarkei, Cyrenopsis* cf. *meeki* and *C. balli* were possibly shallow burrowers, but their ecology requires further study. *Cyrenopsis* has its closest affinities with brackish and freshwater forms (Casey, 1955). *Tancretella plana* and *Periplomya* cf. *robinaldina* were probably also burrowers.

The primitive tellinacean species *Tancredia (Corburella) trigoniformis, Tatella maranoana* and *Maranoana etheridgei* are very well represented in the Minmi fauna. Modern representatives of the Tellinacea are actively burrowing deposit feeders, peculiarly characteristic of beach, littoral and other shallow water environments. A comparable mode of life may be inferred for the primitive species, on the grounds of their morphological similarities to living species.

Panopea maccoyi, specimens of which have been observed in living positions, was apparently a deep burrower. It may have occupied a niche similar to Recent species of *Panopea* which are deep burrowing, comparatively sessile suspension feeders, found mainly in shallow water.

It seems likely that the fauna comprises species from a number of littoral and near-coastal shallow water communities. Possibly, the high degree of taxonomic diversity displayed by the Minmi fauna suggests conditions of normal salinity, as numbers of species decline as salinity falls in modern seas (Pearse and Gunter, 1957, p. 149).

AGE AND CORRELATION

The transgressive nature of the Minmi Member and the absence of well dated index fossils such as ammonites from its fauna, make precise age determination and correlation difficult.

The Aptian Roma Formation [now termed the Doncaster Member of the Wallumbilla Formation (Vine *et al.,* 1967)], which conformably overlies the Minmi Member exhibits the closest faunal relationships (Day, 1964, p. 14). Of the 25 species described in this paper, slightly more than half (13) are common to both the Minmi Member

and the Roma Formation. They are *Acteon ? hochstetteri, Tatella maranoana, Maranoana etheridgei, Tancretella plana, Fissilunula clarkei, Cyrenopsis* cf. *meeki, Inoperna ensiformis, Eyrena linguloides, Camptonectes socialis, Maccoyella barklyi, Maccoyella subangularis, Pseudavicula anomala* and *Panopea maccoyi. Peratobelus australis* may also be added to the list, if belemnites from the Minmi Member are correctly referred to that species. Two other species in common, *Lingula* cf. *subovalis* and *Euspira reflecta,* are excluded from the list, as they range through the entire Aptian-Albian sequence in the Eromanga Basin.

Tatella maranoana, Tancretella plana, Fissilunula clarkei, Maccoyella barklyi, and *Pseudavicula anomala* are particularly characteristic of bivalve faunas associated with Aptian ammonites in the Blackdown Formation (Carpentaria Basin), Doncaster Member of the Wilgunya Formation (Northern Eromanga Basin) (proposed by Vine and Day, 1965, since revised, Vine *et al.*, 1967), and the Roma Formation (Surat Basin). They may be regarded as Australian Aptian index species. Likewise, the belemnite genus *Peratobelus* is probably indicative of the Australian Aptian.

The occurrence of these forms strongly suggests an Aptian age for the Minmi fauna, as does the large number of species in common with Aptian faunas. However, the total time ranges of the "Roma species" are not firmly established. This is particularly the case with the lower (older) time range limits, as Neocomian–Aptian marine sequences in this region are little known and appear to be incomplete. Recent biostratigraphic work in the reasonably complete Aptian–Albian sequences of the Eromanga Basin indicates that the upper (younger) range limits of these species are uppermost Aptian.

Nine species from the Minmi Member have not been reported from the overlying Roma Formation. They are *Neritopsis minmiensis, "Nuculana" minmiensis, Tancredia* (*Corburella*) *trigoniformis, Cyrenopsis balli, Meleagrinella woodsi, Meleagrinella* sp., *Eyrena tatei, Thracia primula* and *Periplomya* cf. *robinaldina.* The first five of these are new species with little immediate value for age determination; the last mentioned closely resembles a European Lower Aptian species.

The absence of *Eyrena tatei* and *Thracia primula* in collections from the Roma Formation may be due to collection failure, as neither species occurs in abundance. Specimens very like *Thracia primula* have been observed in Albian sediments of the Barcaldine area.

Meleagrinella woodsi and *Meleagrinella* sp. both have strong Neocomian affinities. *Meleagrinella woodsi* is closely related to *M. superstes* Spitz (1914) from the Guiemal Sandstone of India. Forms reported from Neocomian sediments near Stanwell by Whitehouse (1946), the Neocomian of the Laura Basin by Woods (1963a, b), and the Neocomian Jowlaenga Formation of the Dampier Peninsula of Western Australia by Brunnschweiler (1960) are similar to *Meleagrinella woodsi* and *Meleagrinella* sp. However, apart from similarities in *Meleagrinella* species Neocomian faunas are quite distinct, especially the early Neocomian (Valanginian ?) faunas at Stanwell and in the Dampier Peninsula.

In the Laura Basin, possibly younger (Hauterivian) faunas associated with *Hatchericeras lakefieldense* Woods (1962) have a similar generic composition. At present these faunas are undescribed, but in unpublished reports Woods (1963a, b) notes the occurrence of the genera *Camptonectes, Meleagrinella, Cyrenopsis, Tatella,* and species congeneric with *Tancretella* and *Maranoana.* Differences at the specific level may be due to age or geographic separation, but in view of the closeness of faunal relationships between the Minmi Member and the Roma Formation, the former interpretation is preferred.

As the Minmi Member was probably deposited in shallower water than the Roma Formation, some of the observed differences in fauna may be ecological. Assessment of such differences would be hazardous, as the fauna of the Minmi Member occurs as a thanatocoenose.

In summary, close faunal relationships with the Roma Formation indicate a probable Aptian age for the fauna of the Minmi Member. The presence of *Meleagrinella* species of Neocomian affinity coupled with evidence from the stratigraphic position of the Member suggest that the fauna may be slightly older than that of the Roma Formation. Further, undescribed faunas of possible Hauterivian age from the Laura Basin are comparable generically, but not specifically. Possibly this indicates that the Minmi fauna is younger. Thus the fauna of the Minmi Member is probably of early Aptian age, although it may possibly be late Neocomian (Barremian).

Like the Roma Formation, the Blackdown Formation and the Doncaster Member of the Wilgunya Formation are probably slightly younger than the Minmi Member. On stratigraphic grounds, sediments most likely correlated with the Minmi Member are the sandstones which conformably underlie the latter units.

From the Wrotham Park Sandstone underlying the Blackdown Formation of the Carpentaria Basin, Woods (1961) reported only *Macoyella barklyi* and an undescribed terebratuloid brachiopod. Little may be said of the age of this unit.

On the northern margins of the Eromanga Basin the Doncaster Member conformably overlies the Gilbert River Formation. Most of the marine fossils described from this unit are from the vicinity of Croydon. Etheridge Jnr. (1892) described the brachiopod *Rhynchonella croydonensis,* the patelliform gastropod *Siphonaria samwelli,* and the bivalves *Maccoyella barklyi* var. *mariaeburiensis, Teredo* sp. ind. *Plaucuna* sp. ind., and *Ostrea* sp. ind. Laing and Power (1959) recorded the marine fauna of the Gilbert River Formation as *Rhynchonella croydonensis, R.* sp. nov., *Maccoyella corbiensis, M. barklyi, M. substriata,* and *Peratobelus australis.* In an unpublished preliminary report Dickins (1960b) identified from the formation *Rhynchonella croydonensis,* a terebratuloid, patelliform

gastropods *Acmaea* ? sp. and cf. *Siphonaria, "Natica"* cf. *variabilis, Peratobelus* sp., *Fissilunula clarkei, Cyrenopsis* cf. *meeki, Maccoyella barklyi* var. *mariaeburiensis, Entolium* sp., *Plagiostoma* sp., *"Ostrea"* sp., *Cucullaria* sp., two Trigoniid species, and the genera *Nuculana, Panopea* and *Parallelodon* doubtfully. As noted by Dickins (1960b), occurrences of *Fissilunula clarkei, Cyrenopsis* cf. *meeki,* and *Maccoyella* and *Peratobelus* species suggest an Aptian age, although the stratigraphic significance of other species cannot be assessed at present. No *Meleagrinella* occurrences have been reported, and the marine portion of the Gilbert River Formation may or may not be equivalent to the Minmi Member.

On the north-western margins of the Eromanga Basin the lower part of the Wilgunya Formation rests conformably on the Longsight Sandstone. In unpublished reports on the fauna from marine horizons near the top of this sandstone, Hill (1960) and Dickins (1960b) record *Fissilunula clarkei, Cyrenopsis* cf. *opallites, Cyrenopsis* sp., *Mytilus inflatus, "Mytilus" primulafontensis,* ? *Mytilus* sp., *Syncyclonema socialis, Maccoyella* sp., ? *Thracia* sp., ? *Panopea* sp., and *Natica variabilis.* Both authors correctly correlated the fauna with that of the Aptian Roma Formation.

In the Tambo area on the eastern margin of the Eromanga Basin, a rather similar fauna occurs in sandstone underlying Aptian mudstones. *Meleagrinella* has not been reported from either area, which may mean that these sandstones are younger than the Minmi member. The significance of this is discussed in the following section.

PALAEOGEOGRAPHIC ASPECTS

Sediments of the Minmi Member represent the initial deposits of a transgressive early Aptian sea. Mineralogically they resemble those of underlying freshwater units, but are distinguished by their glauconite. Thus sediments of the Minmi Member represent a continuance of Surat Basin "Jurassic type" sedimentation, following the onset of marine conditions. They are in a sense true "transition beds" such as might be expected following encroachment of the sea onto a near coastal swamp environment. In the Eromanga Basin such "transition beds" seem absent. There the marine sequence begins abruptly, often with conglomerates, suggesting disconformity. This may mean the sea invaded a more terrestrial environment in the Eromanga Basin.

By this interpretation, the basal sands of the marine transgression would be younger in the Eromanga Basin than in the Roma-Wallumbilla area of the Surat Basin. The absence of *Meleagrinella* species from basal marine sands in the Eromanga Basin, and their presence in the Roma–Wallumbilla area may be supporting evidence. Admittedly the dearth of well-documented index species makes palaeontological control weaker than is desired.

The hypothesis of a transgression towards the west and north-west implies a connection of the Surat Basin with an ocean in the east. Such a connection was proposed by Bryan and Whitehouse (1926) to explain faunal similarities of the Maryborough and Roma Formations. Considering the marked tectonic contrast between the geosynclinal Maryborough Basin and the cratonic Surat Basin, the observed faunal similarity seems remarkable, if no seaway existed between the two.

The possibility that species of the Minmi fauna are immigrants from the east also has a bearing on generic relationships with possible Hauterivian faunas of the Laura Basin. Similarities noted may result from derivation of both faunas from a common source area, the Cretaceous forerunner of the Pacific Ocean.

Aptian marine transgression from the Surat Basin into the eastern part of the Eromanga Basin may have been accompanied by more or less simultaneous transgression into the Carpentaria Basin and the northern part of the Eromanga Basin. Consideration of these is beyond the scope of the present work.

SYSTEMATIC DESCRIPTIONS

Phylum	BRACHIOPODA
Class	INARTICULATA
Order	ATREMATA
Superfamily	LINGULACEA
Family	LINGULIDAE
Genus	*Lingula* Bruguière, 1789

Type species (*I.C.Z.N.* pending) (Rowell, 1964).—*Lingula anatina* Lamarck, 1819. Recent, Moluccas, and Philippines.

Lingula cf. *L. subovalis* Davidson, 1852.
Pl. 1, figs. 1-2

Synonymy.—

Cf. 1852 *Lingula subovalis* Davidson, p. 7, pl. 1, figs. 29-30.
1870 *Lingula ovalis* Sowerby; Moore, p. 236, 239, pl. 10, fig. 14.
1889 *Lingula subovalis* Davidson; Tate, p. 230.
1892 *Lingula ovalis* Sowerby; Etheridge Jnr., p. 444, pl. 20, fig. 14.
1901 *Lingula subovalis* Davidson; Etheridge Jnr., p. 12.
1902a *Lingula subovalis* Davidson; Etheridge Jnr., p. 8, pl. 1, fig. 1.
1927 *Lingula* cf. *subovalis* Davidson; Whitehouse, p. 145.
1960 *Lingula subovalis* Davidson; Day, p. 311.
1964 *Lingula* cf. *L. subovalis* Davidson; Day, table 3.
1966 *Lingula subovalis* Davidson; Ludbrook, p. 193.

Material.—Abundant separated valves from locality RD.78.

Description.—Small; thin-shelled; elliptical-ovoid; equivalve; weakly convex; anterior margin bluntly rounded; posterior margin more acutely rounded; ornament of strong concentric growth lines.

Dimensions (mm.).—

	Length	Width
F 7902 G.S.Q. ..	9·5	4·5
F 7903 G.S.Q. ..	8	4
F 7904 G.S.Q. ..	9·3	4·8
F 7905 G.S.Q. ..	8	4
F 35625 U.Q. ..	11·5	6·5

Remarks.—*Lingula subovalis* Davidson (1852) from the Upper Greensand (Cenomanian) of England is comparable in shape and size, but the Minmi specimens seem to have a stronger ornament.

Moore (1870) identified the species with the English Jurassic *Lingula ovalis* Sowerby, and even though he seems to have regarded the Cretaceous *L. subovalis* as a synonym (p. 236), this occurrence is listed as evidence for the Jurassic age of the fauna (p. 239).

Occurrence.—Minmi Member: RD.78; Minka (Whitehouse, 1927). Moore (1870, p. 236) used this species for correlating faunas from isolated localities. Curiously, it has been noted at only two localities in the Roma–Wallumbilla area. "Wollumbilla" and "Amby River, Mitchell Downs," localities given by Moore, are in the Roma Formation. Very similar linguloid brachiopods occur in the Jones Valley and Allaru Members of the Wilgunya Formation and the Mackunda Formation of the Eromanga Basin, and in South Australia.

Phylum	MOLLUSCA
Class	CEPHALOPODA
Subclass	COLEOIDEA
Order	BELEMNITIDA
Family	BELEMNITIDAE
Subfamily	DIMITOBELINAE

Remarks.—Roger (1952) and Stevens (1965) regard the family Dimitobelidae Whitehouse (1924) as a subfamily of the Belemnitidae, and this view is adopted here. Members of this distinctive Indo-Pacific subfamily are characterized by the possession of two ventro-lateral grooves.

Genus *Peratobelus* Whitehouse, 1924

Type species (by original designation).—*Belemnites oxys* Tenison Woods, 1883. Lower Cretaceous (Aptian), Great Artesian Basin, Australia.

? *Peratobelus australis* (Phillips), 1870

Pl. 1, figs. 22-23, text fig. 1a–d

Synonymy.—

? 1870 *Belemnites australis* Phillips, p. 258, pl. 16, figs. 1, 2, 5.
1960 *Peratobelus australis* (Phillips), Day, p. 311.
1964 *Peratobelus australis* (Phillips), Day, table 3 (*pars.*).
1964 *Peratobelus* sp. Day, table 3 (*pars.*).

Material.—One reasonably complete guard, one lacking the alveolar region and several fragmentary guards.

Description.—Guard of medium size, elongate, moderately robust. Length about six times maximum diameter. Outline slightly hastate. Profile similar to outline. Cross section elliptical. Lateral surfaces flattened in alveolar region and on the anterior half of the stem; dorsal surface convex; ventral surface very weakly convex. Apex almost central. Apical angle approximately 50 deg. Lateral surfaces bearing three grooves. Ventro-lateral grooves long; narrow; about 0·5 mm. in width; very deeply impressed; straight in the alveolar region; gently curved towards the ventral surface on the stem region; bent sharply towards the dorsal surface near the termination 10 mm. from the apex. Medio-lateral grooves shallow; broad; anterior width about 3 mm.; tapered posteriorly; finally fading 15 mm. from the apex. Dorso-lateral grooves shallow; anterior width about 1·5 mm.; short; tapered posteriorly; terminating 25 mm. from the apex. Alveolus apparently short. Apical line subcentral.

*Dimensions.**—

—	Actual length of guard preserved	Total length of guard (L)	Minimum transverse diameter (dtm)	Maximum transverse diameter (dtM)	Minimum saggital diameter (dsm)	Maximum saggital diameter (dsM)
F 35511 U.Q. ..	37	..	8·5	9·5	9	9·5
F 35606 U.Q. ..	55	65 (est.)	8·20	9·25	9	10

* Dimensions measured after the scheme in Avias (1953, p. 158–159)

Remarks.—During preliminary examination these specimens were referred to *Peratobelus australis,* a species originally described by Phillips (1870) as *Belemnites australis.* Under this name Phillips included two distinct forms. Tate (1880, p. 105) drew attention to this, commenting that "the form represented by figures 3 and 4 cannot be far removed, if separable, from *B. canhami.*" All subsequent workers including Etheridge Jnr. (1892; 1920a, b) and Whitehouse (1924) have adopted this course, and have regarded the specimens from "Ward Creek," illustrated by figures 3 and 4 on plate 16, as representatives of *Belemnites canhami* (= *Dimitobelus canhami* = *D. diptychus*). To formalize this procedure the lectotype of *Belemnites australis* is here selected as the specimen from "Queensland" figured by Phillips (1870, pl. 16, figs. 1 and 2).

Guards from the Minmi Member have comparable apical characters and an outline and profile similar to that here selected as lectotype of *P. australis.* However, the ventro-lateral grooves of the lectotype appear to be quite straight and do not extend as far towards the apex. In addition, medio-lateral and dorso-lateral grooves displayed by the present

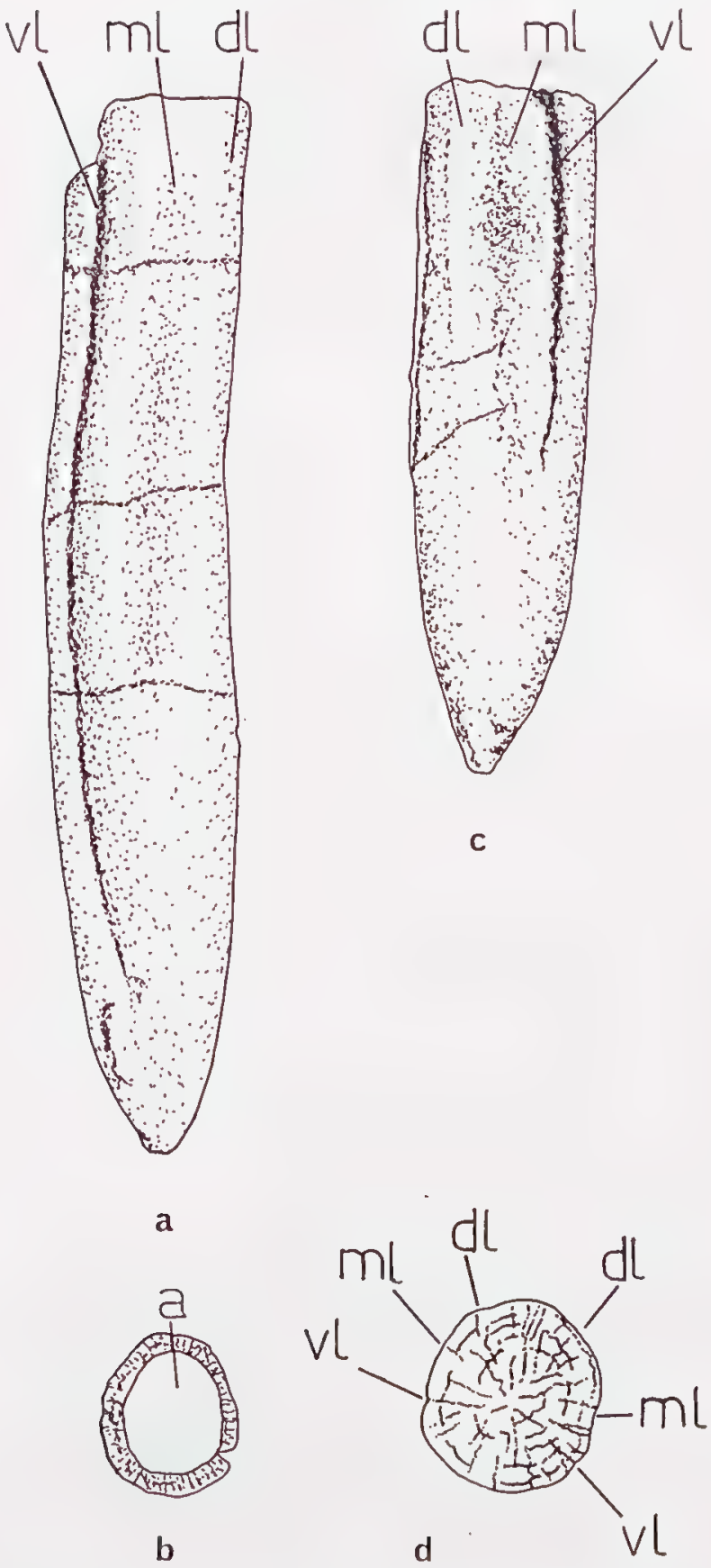

FIG. 1.

Lateral grooves of guards of ? *Peratobelus australis* (Phillips). *a.* right lateral view, x 2 (F 35606 U.Q.); *b.* cross section, x 2 (same specimen); *c.* left lateral view, x 2 (F 35511 U.Q.); *d.* cross section, x 2 (same specimen) *a* alveolus; *dl* dorso-lateral groove; *ml.* medio-lateral groove; *vl* ventro-lateral groove.

specimens, are not mentioned by Phillips. For these reasons the Minmi specimens are only doubtfully referred to *Peratobelus australis*.

Very similar ventro-, medio- and dorso-lateral grooves occur on a specimen (F 8431 G.S.Q.) from the "East bank of the Walsh River, 0·6 miles north of Boomers Hole (W 10)," in the Blackdown Formation. This guard, which was identified by Woods (1961) as *Peratobelus* sp., is approximately the same size as those from the Minmi Member but is more tapered apically.

The arrangement of the lateral grooves on guards from the Minmi Member closely resembles that illustrated by Gustomesov (1962, fig. 3A–N) as typical of the subfamily Cylindroteuthinae. In the case of the ventro-lateral grooves the correspondence in length and in ventral curvature near the posterior extremity is particularly striking.

Peratobelus oxys, the type species of *Peratobelus,* has lateral grooves that closely resemble those of the lectotype of *P. australis* as figured by Phillips (1870, pl. 16, figs. 1 and 2). The ventro-lateral grooves are straight, strongly impressed and are confined to the anterior portion of the guard; medio-lateral and dorso-lateral grooves are not apparent. However, the lectotype of *P. australis* and specimens of *P. oxys* examined by the writer are much larger guards than those from the Minmi Member. Possibly they represent more mature individuals which have not retained all the features of the lateral furrows.

If the Minmi specimens represent immature or juvenile individuals of *Peratobelus australis,* the similarity of their lateral grooves to those of the Cylindroteuthinae may be of some taxonomic significance. Gustomesov (1962) interprets the lateral grooves of belemnites as fin attachment scars. He stresses their value for distinguishing major groups (families and subfamilies) and evaluating their taxonomic relationships. Thus *Peratobelus* may be more closely related to members of the predominantly Jurassic Cylindroteuthinae than to the Dimitobelinae. Similarities of the double lateral lines and grooves of *Dimitobelus* to those of the Jurassic Belemnopsinae and the Upper Cretaceous Belemnitellinae have lead Glaessner (1957), Gustomesov (1962) and Stevens (1965) to suggest that the closest relationships of the Dimitobelinae are with these groups.

Occurrence.—Minmi Member: RD.6 ?; RD.95; RD.99; RD.207 ?; L.143 G.S.Q.

Range.—Apparently Aptian.

Class	GASTROPODA
Subclass	PROSOBRANCHIA
Order	ARCHAEOGASTROPODA
Suborder	NERITOPSINA
Superfamily	NERITACEA
Family	NERITOPSIDAE
Subfamily	NERITOPSINAE
Genus	*Neritopsis* Grateloup, 1832

Type species (by original designation).—*Neritopsis moniliformis* Grateloup, 1832. Miocene, France.

Neritopsis minmiensis sp. nov.

Pl. 1, figs. 3-4

Synonymy.—

1927 *Natica* ? sp. nov. Whitehouse, p. 146.
1964 *"Nerita"* sp. nov. Day, p. 14.
1964 *"Nerita"* sp. Day, table 3.

Material.—Several specimens retaining calcareous shell. *Holotype.*—F 7896 G.S.Q. (L.143). *Paratype.*—F 7895 G.S.Q. (L.143).

Diagnosis.—Medium-sized *Neritopsis* with slightly protruding spire; body whorl ornament of six strong spiral ribs and fine collabral lines.

Description.—Shells of medium size; three whorls; spire only slightly protruding; body whorl globose, evenly convex, bearing six, strong spiral ribs and fine collabral lines; ornament less prominent on earlier whorls; aperture orbicular, entire, inner lip thickened, without tubercle.

Dimensions (mm.).—

	Height	Height of Aperture	Maximum Diameter
Holotype F 7896 G.S.Q.	14	10	13
Paratype, F 7895 G.S.Q.	–	–	10+

Remarks.—This distinctive gastropod has been found at only one locality (L.143). The species is apparently that identified from this same locality by Whitehouse (1927) as *Natica* ? sp. nov. No comparable species have been observed.

Occurrence.—L.143 G.S.Q. Minmi Member.

Range.—Probably Aptian.

Order MESOGASTROPODA
Superfamily NATICAEA
Family NATICIDAE
Genus *Euspira* Agassiz, 1838

Type Species (by subsequent designation, Dall, 1915, p. 106, or Newton, 1915, p. 233).—*Natica glaucinoides* Sowerby, 1812. Eocene, Europe.

Remarks.—There has been considerable confusion concerning the type species of *Euspira*. The first valid designations appear to be those of Dall (1915, p. 106) and Newton (1915, p. 233), but which has priority is uncertain. Additional confusion has been introduced by differing interpretations of the type species, *Natica glaucinoides*. On one hand, Findlay and Marwick (1937, p. 50) state the species has a prominent funicle, and thus the genus differs from *Lunatia* Gray. On the other, Sohl (1960, p. 122) interprets the species as non-funiclate, and regards *Lunatia* as a synonym of *Euspira*.

Euspira reflecta (Moore), 1870

Pl. 1, figs. 7-9

Synonymy.—

1870 *Delphinula reflecta* Moore, p. 256, pl. 10, fig. 21.
1870 *Natica variabilis* Moore, p. 256, pl. 10, fig. 15 *non* Reeve, 1855.
1872 *Natica lineata* Etheridge Snr., p. 342, pl. 21, fig. 1 *non* Bolten, 1798.
1882 *Natica variabilis* Moore; Tate, p. 149.
1884 *Natica* sp. Hudleston, p. 339, pl. 11, fig. 4.
1885 *Natica* sp. Tate, p. 75.
1885 *Natica variabilis* Moore; Tate, p. 75.
1889 *Natica variabilis* Moore; Tate, p. 230.
1890 *Turbo* ? sp. Hudleston, p. 243, pl. 9, fig. 3.
1892 *Delphinula* ? *reflecta* Moore; Etheridge Jnr., p. 485, pl. 29, fig. 12.
1892 *Natica variabilis* Moore; Etheridge Jnr., p. 485, p. 573, pl. 31, figs. 2, 3.
1901 *Natica variabilis* Moore; Guerich, p. 489, pl. 19, fig. 7.
1902a *Natica variabilis* Moore; Etheridge Jnr., p. 42, pl. 6, figs. 15-17.
1902b *Pseudamaura variabilis* (Moore); Etheridge Jnr., p. 40, pl. 2, figs. 9-12.
1902b *Pseudamaura reflecta* (Moore); Etheridge Jnr., p. 42, pl. 2, figs. 13-16.
1915 *Euspira variabilis* (Moore); Newton, p. 232, pl. 6, figs. 20-23.
1920 (*Pseudamaura* or *Ampullina*) *variabilis* (Moore), Etheridge Jnr., p. 12, pl. 2, figs. 39-41.
1925 *Natica* (*Lunatia*) *variabilis* (Moore); Whitehouse, p. 34; pl. 1, fig. 12.
1927 *Natica* (*Lunatia*) *variabilis* (Moore), Whitehouse, p. 146.
1927 *Euspira eyrensis* Findlay, p. 499 (nom. nov. for *Natica variabilis* Moore).
1960 *Natica* (*Lunatica*) *variabilis* (Moore); Day, p. 311.
1964 *Euspira eyrensis* Findlay; Day, table 3.
1966 *Euspira reflecta* (Moore); Ludbrook, p. 184, pl. 26, figs. 1-4.

Material.—Numerous poorly preserved internal and external moulds.

Diagnosis.—Thick shelled *Euspira;* size variable; ornament of orthocline, irregularly spaced, thick growth ridges and fine growth lines, which become prosocline near the aperture in larger specimens.

Description.—Shell thick; size variable; shape naticoid; height slightly greater than diameter; three whorls; spire whorls small, body whorl large, evenly convex; sutures impressed; umbilicus small; ornament of orthocline, irregularly spaced, thick growth ridges and fine growth lines, which become prosocline near the aperture in larger specimens; aperture large, ovate; labral features not visible in this material.

Dimensions (mm.).—

	Height	Height of Aperture	Maximum Diameter
F 7890 G.S.Q. ..	20+	15	18
F 7891 G.S.Q. ..	15	12	13
F 9191 G.S.Q. ..	11	7	9
F 9192 G.S.Q. ..	9+	6	9
F 9193 G.S.Q. ..	9+	6	8
F 35682 U.Q. ..	22	15	18

Remarks.—Generic classification of fossil naticid species is difficult, and a glance at the synonymy shows the present one to be no exception. The reference to *Euspira,* originally suggested by Newton (1915, p. 233), has been adopted by Ludbrook (1966). This reference is tentatively accepted here, but unfortunately, the Minmi specimens do not reveal the important characters of the inner lip.

Moore (1870) figured a large specimen showing ornament as *Natica variabilis,* and a smaller internal mould as *Delphinula reflecta.* Both specimens were from "Wollumbilla". Their similarity was mentioned by Etheridge Jnr. (1902b, p. 41), while Newton (1915, p. 232-233) thought the two conspecific. The latter has page precedence, so the name *Euspira eyrensis* proposed by Findlay (1927, p. 499) for the preoccupied *N. variabilis* Moore is not required. This is also the view taken by Ludbrook (1966, p. 185).

Occurrence.—Minmi Member: RD.6; RD.26; RD.78; RD.94; RD.97; RD.109; RD.128; RD.205; RD.207; L.142; L.143; L.144; L.150; L.151; L.269; L.272 G.S.Q.; L.2162 U.Q.; Red Hill; Blyth Creek near Blythesdale Station.

Euspira reflecta is a commonly occurring, widely distributed, long ranging species. In the Surat Basin it occurs in the Minmi Member and the Roma Formation; in the Eromanga Basin it ranges through the entire Aptian–Albian sequence. The species has also been reported from sediments of the Great Artesian Basin in South Australia (Etheridge Jnr. 1902a; Whitehouse, 1925; Ludbrook, 1966) and New South Wales (Guerich, 1901; Etheridge Jnr., 1902b; Newton, 1915) and from the Maryborough Basin (Etheridge Jnr., 1892). Trechmann (1917) reported *Natica* (*Euspira*) *variabilis* Moore from the Senonian of New Zealand, a misidentification corrected by Wilckens (1922).

Subclass	OPISTHOBRANCHIA
Order	PLEUROCOELA
Superfamily	ACTEONACEA
Family	ACTEONIDAE
Genus	*Acteon* Montfort, 1810

Type Species (by monotypy).—*Voluta tornatilis* Linné, 1767. Recent, European waters.

Acteon ? hochstetteri Moore, 1870
Pl. 1, figs. 5-6

Synonymy.—

1870 *Actaeon hochstetteri* Moore, p. 256, pl. 10, fig. 19.
1892 *Cinula hochstetteri* (Moore); Etheridge Jnr. p. 484.
1961 *Acteon hochstetteri* Moore; Woods, p. 6.
1964 *"Actaeon" hochstetteri* Moore; Day, p. 18, table 3.

Material.—1 external and 2 internal moulds.

Diagnosis.—Small *Acteon*-like form; spiral angle about 70 deg.; body whorl bearing numerous (25 to 30), shallow, spiral grooves; apertural features unknown.

Description.—Small, *Acteon*-like; at least 4 whorls; spiral angle about 70 deg.; sutures moderately impressed; body whorl large, bearing about 25 shallow, spiral grooves; aperture not visible.

Dimensions (mm.).—

	Height	Maximum Diameter
F 7846 G.S.Q.	5	3
F 7847 G.S.Q.	6+	4

Remarks.—Etheridge Jnr. (1920, p. 16) noted that this species was only imperfectly known, and the present specimens contribute little additional information. The species is doubtfully referred to the genus *Acteon* as the apertural and labral features are not known.

Cinula hochstetteri figured by Etheridge Jnr. (1902a, pl. 6, fig. 25) from the Lake Eyre Basin of South Australia, has fewer spiral grooves and probably represents a distinct species.

Etheridge Jnr. (1920, p. 16) suggested that *Actaeonina* sp. figured by him (1920, pl. 2, figs. 30, 32, 37) from the "Glanmire Block, Tambo," might be conspecific with *Acteon ? hochstetteri*. However, the Glanmire specimens (F 1691, F 1348a–f. G.S.Q.) have higher spires and more impressed sutures.

Occurrence.—Minmi Member: RD.285; L.149 G.S.Q. In the Great Artesian Basin *Acteon ? hochstetteri* is apparently a widely distributed, though infrequently occurring species. It is found in both the Minmi Member and the Roma Formation (Surat Basin), the Blackdown Formation (Carpentaria Basin) (Woods, 1961), and may occur in the Aptian sediments of the northern Eromanga Basin.

Range.—Aptian.

Class	BIVALVIA (= PELECYPODA; LAMELLIBRANCHIA)
Subclass	PALAEOTAXODONTA
Order	NUCULOIDA
Superfamily	NUCULANACEA
Family	NUCULANIDAE
Genus	*Nuculana* Link, 1807

Type Species (by monotypy).—*Arca rostrata* Chemnitz, 1784 (= *Arca pernula* Mueller, 1779). Recent, northern coasts of Europe.

Remarks.—The anterior umbones, ornament, teeth and to some extent the ligament features of *"N". minmiensis* are comparable with those of the genus *Nuculana sensu stricto*. Differences occur in the nature of the rostrum and escutcheon. The type species of *Nuculana* has a bicarinate rostrum and a weakly impressed escutcheon visible in lateral view. In *"N". minmiensis* the escutcheon cannot be seen in this view, and there is only a single, weakly impressed carina. Furthermore, the pallial characters of *N. minmiensis* are not known. At present the species seems best referred to *Nuculana sensu lato*.

"Nuculana" minmiensis sp. nov.
Pl. 1, figs. 10-14; text fig. 2

Synonymy.—

1927 *Nuculana elongata* (Etheridge Snr.); Whitehouse, p. 146.
1960 *Malletia elongata* (Etheridge Snr.); Day, p. 311.
1964 *Nelio randsi* (Etheridge Jnr.); Day, table 3 (*pars.*).

Material.—Numerous specimens preserved as internal and external moulds. *Holotype.*—F 35512 U.Q., a right valve internal mould from RD.99. *Paratypes.*—F 35667 U.Q., a right valve internal mould from RD.99; F 7844 G.S.Q., a left valve external mould from L.270; F 7845 G.S.Q., a left valve internal mould from L.272.

Diagnosis.—Transversely elongate *Nuculana;* length almost twice height; umbones situated in anterior one-third of shell; carina weak; ornament of very fine concentric growth lines.

Description.—Shell of small to medium size; inequilateral; weakly inflated and produced posteriorly; transversely elongate, length almost twice height;

umbones obtuse, situated in the anterior one-third of the shell. Antero-dorsal margin weakly arched, merging imperceptibly with the convex anterior end of the shell; postero-dorsal margin gently concave; ventral margin gently convex, rising posteriorly to meet the postero-dorsal margin in the dorsal quarter of the shell. Escutcheon deeply impressed, approximately at right angles to the plane of the hinge; bounded by a very weak carina which extends from the umbo to the postero-dorsal extremity; posterior portion of carina underlain on flank by slight sulcus. Hinge with numerous taxodont teeth, the larger ones distinctly chevron shaped. Anterior row shorter than posterior row, with approximately 12–14 teeth; posterior row with about 20 teeth which occupy most of the postero-dorsal margin. Teeth diminish rapidly in size near the umbo. Chondrophore obscure, very small. Anterior adductor scar more strongly impressed than the posterior. Some specimens with a small elongately oval pedal adjustor scar just anterior to the umbo. Pallial characters not visible. Ornament of very fine concentric growth lines.

Dimensions (mm.).—

	Length	Height	Inflation
Holotype, F 35512 U.Q. . .	27	14	4 (1 valve)
Paratype, F 35667 U.Q. . .	19	10	–
Paratype, F 7844 G.S.Q. . .	16	7	3 (1 valve)
Paratype, F 7845 G.S.Q. . .	19	10	–

FIG. 2.

Dentition and ligament pit (*l*) of right valve of *"Nuculana" minmiensis* sp. nov., latex cast of internal mould, paratype, x 2·2 (F 35667 U.Q.).

Remarks.—During preliminary examination this species was referred to *Malletia elongata,* a combination used by Etheridge Jnr. (1902a, b) for *Leda elongata* Etheridge Snr. (1872) and its supposed synonym *Nuculana* (? *Yoldia*) *randsi* Etheridge Jnr. (1892). Findlay (1927) suggested *Neilo randsi* as the correct name. Subsequent examination of the lectotype of *Nuculana randsi* (F 1410 G.S.Q.) from "the Isis River, near the Bundaberg road", figured by Etheridge Jnr. (1892, pl. 26, fig. 10) and that of *Leda elongata* (F 1247 Q.M.) from "Maryborough", figured by Etheridge Snr. (1872, pl. 20, fig. 5), has revealed that *"Nuculana" minmiensis* has more anterior umbones than either of the Maryborough specimens.

Leda angulatostriata described by Sokolov and Bodylevsky (1931, pl. 12, figs. 4-6) and Weir (1933, fig. 14) from the Aptian of Spitzbergen has similar anterior umbones, carinal and rostral features, but is not as posteriorly elongate and has a different ornament.

Nuculana hoelscheri Cox (1961) from the Nanutarra Formation of Western Australia has anterior umbones like *N. minmiensis,* but its ornament of concentric rugae is strikingly different.

The loosely diagnosed and poorly figured species *Leda australis* Moore (1870, p. 251, pl. 12, fig. 7) from "Wollumbilla", which Etheridge Jnr. (1892, p. 469) referred to the genus *Nuculana,* is probably best regarded as a *nomen dubium,* as Moore's specimen is apparently no longer extant.

Occurrence.—Minmi Member: RD.78; RD.82; RD.94; RD.99; RD.109; RD.128; RD.207; RD.285; L.148; L.270; L.272 G.S.Q.; R.199, parish of Euthulla (Whitehouse, 1927).

Range.—Probably Aptian.

Subclass HETERODONTA
Order VENEROIDA
Suborder LUCININA
Superfamily TELLINACEA
Family TANCREDIIDAE

Remarks.—This Upper Triassic-Upper Cretaceous family has variously been classified in the Cardiacea (Meek, 1865), Tellinacea (Chavan, 1950) and questionably in the Lucinacea (Dall, 1895). Equally divergent opinions have been expressed concerning its component genera. Meek (1865) included only *Tancredia* and *Meekia*; Fischer (1887) and Dall (1895) added *Hemidonax* to the list; Cox (1929) added *Corbicellopsis, Eodonax,* and with doubt, *Delia*; at the same time deleting *Hemidonax*; Chavan (1950) deleted *Eodonax* and ? *Delia* from Cox's list, while adding *Protodonax.* Chavan's grouping is accepted here, with *Tatella* and *Maranoana* included in addition.

As here constituted the Tancrediidae comprise deltoid to elongately ovate shells with lucinoid dentition, and in which the pallial sinus is either absent or small. The development of lunule, lateral teeth, and nymphs seems to be variable.

Genus *Tancredia* Lycett, 1850

Type Species (by subsequent designation Morris and Lycett, 1853, p. 91).—*Tancredia donaciformis* Lycett, 1850. Inferior Oolite, England.

Subgenus *Corburella* Lycett, 1850

Type Species (by monotypy).—*Corbula curtansata* Phillips, 1829. Corallian, England.

Remarks.—The species described below as *Tancredia* (*Corburella*) *trigoniformis* belongs to the corbuliform group of *Tancredia* recognised by Cox (1929), who suggested that the name *Corburella* Lycett, based on a misinterpretation of *Corbula curtansata* Phillips, might be retained for this group. This suggestion was adopted by Chavan (1950), who cited the hinge formula as:—

$$\frac{\text{(A III–3a)} \qquad \text{3b} \qquad \text{P I}}{\text{(A II)} \cdot \text{(A IV)} \qquad \text{2(4b)} \qquad \text{P II}}$$

In *T.* (*C.*) *trigoniformis* A III–3a (here referred to as 3a) is strongly developed, while there is no trace of A II, A IV or 4b.

Tancredia (*Corburella*) *trigoniformis* sp. nov.

Pl. 1, figs. 15-21

Synonymy.—

1964 *Tancredia* sp. nov. Day, p. 14.
1964 *Tancredia* sp. Day, table 3.

Material.—Numerous specimens, mostly preserved as internal moulds.

Holotype.—F 35581 A/B U.Q., an internal mould of a specimen with separated valves from locality RD.128. *Paratypes*: F 35562 U.Q., a right valve external mould from RD.99; F 35564 U.Q., right valve internal mould from RD.99; F 35576 U.Q., left valve internal mould from RD.128; F 35578, right valve internal mould from RD.128.

Diagnosis.—Medium-sized *Tancredia* with a trigonoid or corbuliform shape; cardinal teeth well developed, 3a being quite prominent; posterior lateral teeth remote from the cardinals.

Description.—Shell equivalve, often somewhat compressed, trigonoid or corbuliform in shape; produced and somewhat pointed anteriorly; antero-dorsal margin straight, its junction with the ventral margin occurring at about mid-height; other margins convex. Lunule well defined. Umbones prosogyral, closer to the posterior. Cardinal teeth borne on a distinct hinge plate; two in the right valve, one in the left. Left valve cardinal tooth (2) conical, pointed distally and projecting well above the hinge plate; flanked by sockets, the posterior the deeper. Right valve cardinals strong; 3b trigonal, opisthocline, and placed immediately below the umbo; 3a prosocline, situated on the dorsal margin and projecting beyond the plane of 3b. Anterior lateral teeth absent. Posterior lateral teeth remote from the cardinals. Left valve with an obscure laminar lateral (P II) received between a moderately well developed P I and the shell margin which forms P III. Ligament external, seated on a short nymph. Adductor scars dorsal, faint, small, ovate and subequal. Pallial line obscured posteriorly. Ornament of fine concentric growth lines and shallow concentric grooves and ridges about 1 mm. apart near the centre of the ventral margin.

Dimensions (mm.).—

	Length	Height	Inflation
Holotype, F 35581 A/B U.Q.	35	26	6 (1 valve)
Paratype, F 35562 A/B U.Q.	40+	32	9 (1 valve)
Paratype, F 35564 A/B U.Q.	36	28	10 (1 valve)
Paratype, F 35576 A/B U.Q.	34+	27+	6 (1 valve)
Paratype, F 35578 A/B U.Q.	26+	21	6 (1 valve)

Remarks.—*Tancredia* (*Corburella*) *trigoniformis* closely resembles the neotype of the type species of *Corburella, Tancredia curtansata,* figured by Arkell (1934, pl. 38, figs. 9 and 9a), but lacks the antero-ventral sinuation and wing-like extension of the postero-dorsal margin. As far as can be ascertained from Arkell's figure, the hinges of the left valves are similar.

Tancredia subcurtansata Lycett (1863, p. 120; figured Morris and Lycett, 1853, pl. 13, figs. 7a and b) from the Great Oolite of England is also similar, but is more acutely pointed anteriorly, and has a much weaker 3a tooth.

Species of *Tancredia* are not as numerous in the Cretaceous as they are in the Jurassic, and most of the Cretaceous ones seem to be corbuliform types. An exception is *Tancredia schwarzi* Kitchin (1913, p. 139, pl. VII, figs. 9, 9a and 10) from the Neocomian Uitenhage series of South Africa, which probably belongs to the subgenus *Isotancredia* Chavan.

Tancredia (*Corburella*) *trigoniformis* is somewhat like a specimen from the Albian of Alberta, Western Canada, figured by McLearn (1919, pl. 5, fig. 6) as *Tellina dowlingi.* Subsequently, McLearn (1945, pl. 3, fig. 11) refigured this specimen under the name *Tancredia ? dowlingi* var. *silentia* n. var. However, closer comparison is not possible as the hinge of the Canadian specimen is not figured, and the pallial characters of the Minmi specimens are unknown. Another specimen figured by McLearn (1919, pl. 5, fig. 5) as *Tellina dowlingi,* and refigured (1945, pl. 3, fig. 10) as *Tancredia ? dowlingi,* was made a new species, *Tancredia pacia,* by McLearn (1948). This form is more elongate than the Minmi species.

The holotype of *Tancredia stelcki* figured by McLearn (1945, pl. 10, fig. 5) from the Albian Goodrick Formation of Western Canada, is similar in shape, but unfortunately the hinge is not figured. Specimens figured by Imlay (1961, pl. 4, figs. 8–12) from the Albian of Alaska as *T. stelcki,* are less similar, and again no hinges are figured.

Occurrence.—RD.78; RD.99; RD.128; RD.205; RD.207; RD.285; L.150 ?; L.153; L.270; L.271; L.272 G.S.Q.; all within the Minmi Member.

Range.—Probably Aptian.

Genus *Tatella* Etheridge Jnr., 1901

Type Species (by original designation).—*Corbicella ? maranoana,* Etheridge Jnr., 1892. Aptian, Queensland.

Remarks.—*Tatella* was originally referred to the family Psammobiidae (= Garidae) by Etheridge Jnr. (1901). Ludbrook (1966) included the genus in the Tellinidae. However, the dentition and pallial characters of *Tatella* are unlike those of garids and tellinids. *Tatella* is here referred to the Tancrediidae because of the close relationship existing between *Tatella* and the tancrediid *Corbicellopsis* Cox (1929). Both genera are similar in shape, but *Tatella* has a well formed pallial sinus, internal thickening in the umbonal cavity for support of the hinge plate, and lacks the lateral teeth of *Corbicellopsis.*

Tatella maranoana (Etheridge Jnr.), 1892
Pl. 1, figs. 24–26

Synonymy.—

1892 *Corbicella* ? *maranoana* Etheridge Jnr., p. 471 (*pars.*), pl. 27, figs. 4 and 5 only.
1901 *Tatella maranoana* (Etheridge Jnr.), p. 28 (*pars.*)
1925 *Tatella maranoana* (Etheridge Jnr.); Whitehouse, p. 33.
1960 *Tatella maranoana* (Etheridge Jnr.); Day, p. 311.
1964 *Tatella maranoana* (Etheridge Jnr.); Day, p. 18, table 3.

Material.—Numerous internal and external moulds.

Diagnosis.—Elongately ovate *Tatella;* length about 1·8 times height; dorsal margins straight, gently arched, ventral margins convex.

Description.—Comparatively thick shelled; elongately ovate; length about 1·8 times shell height; equivalve; moderately inflated, maximum inflation a little behind the umbones; subequilateral; dorsal margins straight, gently arched; ventral margins convex, anterior and posterior margins tapering, then bluntly rounded; posterior with slight oblique truncation, possibly gaping. Umbones broad, depressed, subcentral to slightly anterior; beaks small, prosogyral. Lunule and escutcheon small, linear. Hinge plate well developed, supported by internal thickening in the umbonal cavity. Left valve with a single, triangular, weakly opisthocline cardinal tooth (2), pointed and upturned distally. Right valve with two strong cardinal teeth (3a, 3b), 3a prosocline, 3b opisthocline, larger than 3a. No lateral teeth. Ligament external, opisthodetic, seated on prominent nymphs. Anterior adductor scar wedge shaped, deeply impressed; posterior adductor scar rounded ventrally, attenuated umbonally; pallial line remote from the margin, with a wide shallow sinus. Ornament of fine concentric growth lines, and less regularly spaced, weak, concentric ribs.

Dimensions.—

	Length	Height	Inflation
F 7901 G.S.Q.	28	15	4 (1 valve)
F 35571 U.Q.	42	23	5 (1 valve)
F 35607 U.Q.	42	23	6 (1 valve)
F 35608	47	24	6 (1 valve)

Remarks.—Specimens from the Minmi Member compare closely with the holotype (F 1314 G.S.Q.) of *Tatella maranoana* and topotypes from the Maranoa River near Mitchell (Roma Formation).

Tatella ? *aptiana* Whitehouse (1925, p. 33, pl. 1, figs. 9, 10) is very similar to *T. maranoana,* but apparently gapes anteriorly and posteriorly.

The strong teeth, slightly anterior umbones, sloping antero-dorsal margins and tapered, bluntly terminated anterior readily distinguish *Tatella maranoana* from *Maranoana etheridgei* n. sp.

"Gari" elliptica Whitehouse (1925) has more anterior umbones and a much deeper pallial sinus than *T. maranoana.*

Occurrence.—Minmi Member: RD.78; RD.82; RD.94; RD.107; RD.109; RD.128; RD.207; RD.283; RD.285; L.269 G.S.Q.; L.2162 U.Q. *Tatella maranoana* also occurs in the Roma Formation and in G.S.Q. collections from the Yengarie and Corporation Quarries (Maryborough Formation). Rather similar forms are known from the Blackdown Formation, the Doncaster Member of the Wilgunya Formation and from South Australia.

Range.—Aptian.

Genus *Maranoana* gen. nov.

Type Species.—*Maranoana etheridgei* sp. nov. *Holotype*: F 1315 G.S.Q. Figured Etheridge Jnr. (1892, pl. 28, figs. 2, 3) as ? *Corbicella* ? *maranoana* from the Maranoa River near Mitchell. Aptian, Roma Formation.

Derivation.—

Maranoana from the Maranoa River, the locality of the holotype. Feminine.

etheridgei—after Robert Etheridge, Jnr.

Diagnosis.—Thin shelled, elongated, oblong shaped, with a rostrate often upturned antero-dorsal extremity; length about twice height; compressed; equivalve; inequilateral; gaping anteriorly and posteriorly. Umbones inconspicuous, situated $\frac{3}{5}$ of shell length from anterior. Lunule and escutcheon wanting; posterior margin truncate, slightly oblique. Left valve with a small, orthocline cardinal tooth (2). Right valve with two minute cardinal teeth (3a, 3b). Lateral teeth absent. Ligament external, probably opisthodetic. Adductor scars not well impressed; anterior scar wedge shaped; posterior scar semicircular. Pallial line with a wide, shallow sinus. Ornament of broad, weakly elevated, irregularly spaced concentric ribs, and fine concentric lines of growth.

Remarks.—*Maranoana* differs from the related *Tatella* Etheridge Jnr. (1901) in its rostrate antero-dorsal extremity and posterior umbones. *Meekia* Gabb and its subgenus *Mygallina* Saul and Popenoe (1962) are similar in shape, especially the latter, but these have a more developed dentition.

Some aspects of the morphology of *Maranoana* may be interpreted in terms of function. The anterior elongation and anterior gape of *Maranoana etheridgei* imply the possession of a large foot, while the pallial sinus and posterior gape indicate the existence of siphons. Considered in conjuction with the compressed, oblong form, these features suggest a burrowing existence. The mode of life may not have been greatly different from that of living tellinaceans, as Owen (1959) suggests that the anterior elongation and associated features of this group may be correlated with the living position and feeding habits of the animal. Recent Tellinaceans burrow deeply for protection while moving horizontally through the bottom deposits on which they feed (Yonge, 1949). One major difference lies in the development of the pallial sinus which, in living

tellinaceans is much deeper than in *Maranoana.* This may indicate lesser development of siphons in *Maranoana,* which may, in turn, be correlated with shallower burrowing.

This genus appears to have a Neocomian to Aptian time range.

Maranoana etheridgei gen. and sp. nov.
Pl. 3, figs. 15–19

Synonymy.—

1892 ? *Corbicella ? maranoana* Etheridge Jnr., p. 471 (*pars.*), pl. 28, figs. 2 and 3 only.
1901 *Tatella maranoana* (Etheridge Jnr.), p. 28 (*pars.*).
1902a *Tatella maranoana* (Etheridge Jnr.), pl. 2, fig. 26 only.
1925 *Tatella* sp. Whitehouse, p. 33.
1925 *Gari ?* sp. Whitehouse, p. 33.
1961 *Tatella* sp. Woods, p. 6.
1964 *Tatella ?* sp. Day, p. 18, table 3.
1964 *? Solemya* sp. Day, p. 14, table. 3.

Material.—Several internal and external moulds, mostly with separated valves, some fragmentary.

Diagnosis.—Elongated, oblong shaped, with a rostrate, often upturned antero-dorsal extremity, and posterior umbones.

Description.—Shell thin; oblong shaped, compressed and elongated; length about twice height; gaping both anteriorly and posteriorly; inequilateral, anterior comprising approximately $\frac{3}{5}$ of shell length. Umbones posterior, inconspicuous. Lunule and escutcheon wanting. Antero-dorsal margin straight or slightly concave, almost parallel to the ventral; postero-dorsal margin straight, meeting the antero-dorsal margin at an angle of about 170 degrees; posterior margin truncate, set almost at right angles to the ventral; anterior margin convex; antero-dorsal extremity pointed or rostrate, often slightly upturned. Hinge line thickened, particularly anteriorly; the anterior thickened area tapers towards the umbo and is bounded above and below by a slightly raised rim or flange. Left valve with a small, orthocline cardinal tooth. Right valve with two minute cardinal teeth flanking the socket which receives the cardinal tooth of the left valve. Ligament external, probably opisthodetic. Adductor scars dorsal, not well impressed; anterior scar wedge shaped, expanding anteriorly; posterior scar rounded. Pallial line not visible in this material. Exterior surface with broad, weakly elevated, irregularly spaced, concentric ribs 1–3 mm. apart, and very fine concentric lines of growth spaced 3–5 per mm.

Dimensions (mm.).—

	Length	Height	Inflation
F 28842 U.Q.	40	20	5 (1 valve)
F 35570	65	28	8
F 35572	62	29	–
F 7861 A/B G.S.Q.	40	20	–

Remarks.—Apart from slight differences in the nature of the posterior truncation, these specimens compare quite closely with the holotype (F 1315 G.S.Q.) figured by Etheridge Jnr. (1892, pl. 28, figs. 2 and 3), from the Maranoa River near Mitchell (Roma Formation). In the holotype the truncation is slightly oblique, and in consequence, its junction with the postero-dorsal margin is less angular. In the Neocomian of the Laura Basin there is a closely related species which differs from *Maranoana etheridgei* in having more median umbones.

Occurrence.—Minmi Member: RD.99; RD.128; RD.205; L.141; L.142 G.S.Q.; L.319; L.2162 U.Q.; Burns Well (60 ft ?), por 90, Kangaroo Ck. *Maranoana etheridgei* is a widely distributed Aptian species which also occurs in the Roma and Blackdown Formation, the Doncaster Member of the Wilgunya Formation, and in G.S.Q. collections from Yengarie Quarry in the Maryborough Basin.

Family Icanotidae

Genus *Tancretella* Ludbrook, 1966

Type Species (by original designation).—*Myacites planus* Moore, 1870. Aptian, Queensland, South Australia and New South Wales.

Remarks.—Ludbrook (1966) refers *Tancretella* to the family Tellinidae, but the strong, blunt cardinal teeth are unlike the characteristically thin, delicate, often bifid teeth of tellinids. *Tancretella* is included in the family Icanotidae herein. The time range of the genus seems to be Neocomian to Albian.

Tancretella plana (Moore), 1870
Pl. 2, figs. 1–4

Synonymy.—

1870 *Myacites planus,* Moore, p. 254, pl. 12, fig. 10.
1870 *Tancredia plana* Moore, p. 254, pl. 13, fig. 3.
1892 *Macrocallista plana* (Moore); Etheridge Jnr., p. 476, pl. 27, figs. 6-8.
1892 ? *Cyprina clarkei* Moore; Etheridge Jnr., pl. 27, fig. 10 only.
1902a *Macrocallista ? plana* (Moore); Etheridge Jnr., p. 35, pl. 5, figs. 7-9.
1902b *Macrocallista ? plana* (Moore); Etheridge Jnr., p. 37, pl. 5, figs. 8, 9.
1927 *Macrocallista ? plana* (Moore); Whitehouse, p. 145.
1961 *Macrocallista plana* (Moore); Woods, p. 6.
1954 *"Myacites" planus* Moore; Day, p. 18, table 3.
1966 *Tancretella plana* (Moore); Ludbrook, p. 179, pl. 24, figs. 8, 10-12.

Material.—Numerous internal and external moulds of separated valves.

Diagnosis.—Large, thick shelled, transversely elongated *Tancretella.*

Description.—Large, thick shelled; transversely elongated; equivalve, slightly compressed; anterior somewhat triangular in shape; posterior rounded; antero-dorsal margin straight, sloping; other margins gently convex. Umbones broad, prominent, situated in the anterior one-third of shell; beaks prosogyral. Lunule well defined; escutcheon deeply impressed. Hinge of left valve with one blunt, trigonal cardinal tooth. Ligament external, opisthodetic, seated on small nymphs. Adductor muscle scars large, dorsal; anterior scar broadly triangular, deeply impressed, bounded posteriorly by a low rib or buttress; posterior scar ovate. Pallial sinus very wide

and very deep, extending to the mid length. Ornament of shallow irregularly spaced depressions marking growth halts and fine concentric growth lines.

Dimensions (mm.).—

	Length	Height	Inflation
F 1332 G.S.Q.	57	35	12 (1 valve)
F 7897 G.S.Q.	69	48	15 (1 valve)

Remarks.—Specimens described from "Gordon Downs" by Etheridge Snr. (1872, p. 348) as *Myacites* sp. ? (pl. 25, fig. 7) and *Tancredia* sp. ? (pl. 25, fig. 8) and assigned an "Oolitic" age, and which were subsequently placed in the synonymy of this species by Etheridge Jnr. (1902a, b) are not considered conspecific with *Tancretella plana.* The specimens in question are from Gordon Downs near Clermont, a Permian locality (J. T. Woods pers. comm.). However, Etheridge Jnr's treatment of *Tancredia plana* Moore (1870) from "Blythesdale, fifteen miles from Wollumbilla" as a synonym is accepted.

As noted in the section on *Fissilunula clarkei,* ? *Cyprina clarkei* Etheridge Jnr. (1892, pl. 27, fig. 10) from the Walsh River (Blackdown Formation) is conspecific with *Tancretella plana. F. clarkei* is less elongate than *T. plana* and has a shallow, not a deep pallial sinus.

Occurrence.—Minmi Member: RD.82; RD.94; RD.97; RD.109; RD.119; RD.128; RD.283; RD.285; L.101; L.139; L.141; L.143; L.149; L.150; L.153; L.269; L.270; L.272 G.S.Q.; L.2162 U.Q.; Red Hill; por. 13, par. Euthulla; R.199, par. Euthulla (Whitehouse, 1927); Minmi near Roma (Etheridge Jnr., 1892); Blythesdale, fifteen miles from Wollumbilla (Moore, 1870).

Tancretella plana is a widely distributed, commonly occurring species, characteristic of Australian Aptian sediments. It occurs in the Blackdown Formation (Woods, 1961), the Doncaster Member (Vine and Day, 1965), the Roma Formation, and in Aptian sediments in South Australia and north-west New South Wales.

Range.—Aptian.

Suborder	ARCTICINA
Superfamily	ISOCARDIACEA
Family	ISOCARDIIDAE
Genus	*Fissilunula* Etheridge Jnr., 1902

Type Species (by monotypy).—*Cytherea clarkei* Moore, 1870. Aptian, Australia.

Remarks.—In proposing the genus *Fissilunula* Etheridge Jnr. (1902b, p. 33) stated *"Fissilunula,* broadly speaking, seems to be an ally of the *Isocardia* group, but generally does not agree with any member of that family known to me." Subsequently, Newton (1915, p. 223) referred the genus to the family Cyprinidae (= Articidae) without comment. Brunnschweiler (1960, p. 32) commented on the similar general appearance of certain astartid and cyprinid genera, although he still regarded *Fissilunula* as an isocardiid.

Etheridge Jnr. on the basis of hinge features, ably demonstrated the relationship between *Isocardia* and *Fissilunula.* In both genera anterior lateral teeth are lacking, while both possess similar cardinal teeth and remote, laminar posterior lateral teeth and prominent nymphs. For this reason *Fissilunula* is here referred to the family Isocardiidae. The genus differs from typical members of the family in that the beaks are neither prominent, nor twisted in a prosogyral spiral, and the valves are not carinate. The lunule furrow from which *Fissilunula* derives its name is not unlike those seen in many species of *Isocardia.*

Fissilunula clarkei (Moore), 1870
Pl. 2, figs. 5–6, text fig. 3a, b

Synonymy.—

1870 *Cytherea clarkei* Moore, p. 250, pl. 13, fig. 1.
1872 *Cyprina expansa* Etheridge Snr., p. 338, pl. 19, fig. 1.
1887 *Cytherea ? clarkei* Moore; Tate, p. 53.
1889 *Cytherea clarkei* Moore; Tate, p. 230.
1892 *Cyprina clarkei* (Moore); Etheridge Jnr., p. 474, p. 568, pl. 26, figs. 18, 19; pl. 27, figs. 9, 11 only.
1892 *Ceromya* ? sp. ind. Etheridge Jnr., p. 571, pl. 26, fig. 20.
1902a *Cyprina* ? (vel *Cytherea*) *clarkei* (Moore); Etheridge Jnr., p. 32, pl. 6, figs. 1, 2.
1902b *Fissilunula clarkei* (Moore); Etheridge Jnr., p. 36, pl. 6, fig. 3; pl. 9, fig. 1; pl. 10, figs. 1, 2; pl. 11, figs. 1, 2.
1915 *Fissilunula clarkei* (Moore); Newton, p. 223, figs. A, B.
1927 *Fissilunula clarkei* (Moore); Whitehouse, p. 146.
1960 *Fissilunula clarkei* (Moore); Brunnschweiler, p. 30, pl. 2, figs. 8, 9; text-figs. 23, 24.
1960 *Fissilunula* cf. *clarkei* (Moore); Day, p. 311.
1961 *Fissilunula clarkei* (Moore); Woods, p. 6.
1964 *Fissilunula clarkei* (Moore); Day, table 3.
1966 *Fissilunula clarkei* (Moore); Ludbrook, p. 174, pl. 23, fig. 19.

Material.—Internal moulds of three left valves and a right valve, all showing hinge features.

Diagnosis.—Large, thick shelled, variably inflated, ovately rhomboidal *Fissilunula.*

Description.—Large, thick shelled, variably inflated, ovately-rhomboidal; equivalve; inequilateral; maximum inflation in the umbonal region. Umbones broad, somewhat flattened; beaks small, prosogyral; situated in the anterior two-fifths of shell. Lunule wide, shallow, crossed by a groove extending from the beak to the anterior cardinal tooth; another groove extends from the beak to the posterior cardinal. Hinge formula

1	3b	P I	P III
2a	2b	4b	P II

2a strong, knob-like; 2b more prominent, opisthocline; 4b smaller, very opisthocline; 1 strong, knob-like, opisthocline; 3b laminar, very opisthocline; posterior portion of ligament seated on prominent nymphs; adductor scars, pallial characters and ornament not visible in these specimens.

Dimensions (mm.).—

	Length	Height	Inflation
F 7898 G.S.Q. ..	96	71	20 est. (1 valve)
F 7899 G.S.Q. ..	104	82	22 est. (1 valve)
F 35710 U.Q. ..	43	36	9 est. (1 valve)

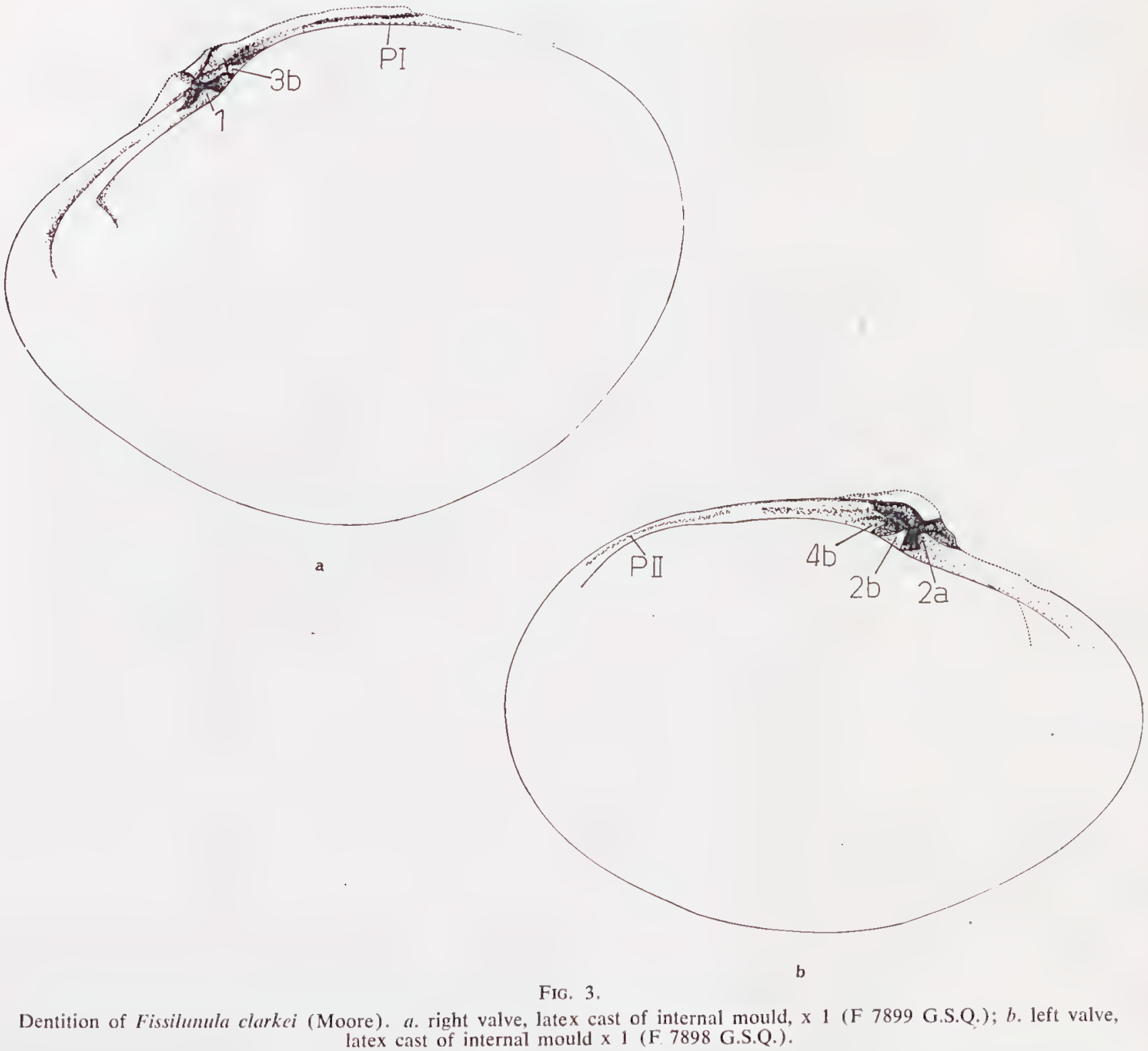

FIG. 3.

Dentition of *Fissilunula clarkei* (Moore). *a.* right valve, latex cast of internal mould, x 1 (F 7899 G.S.Q.); *b.* left valve, latex cast of internal mould x 1 (F 7898 G.S.Q.).

Remarks.—As noted by Etheridge Jnr. (1902b) the species is somewhat variable with regard to shape and inflation. The present specimens are more ovate and less inflated than larger ones observed in the Roma Formation. Smaller specimens may thus become confused with *Tancretella plana.* This is the case with the variety showing a deep pallial sinus mentioned by Etheridge Jnr. (1902b, p. 36). The specimen in question (F 1326 G.S.Q.), which was figured by Etheridge Jnr. (1892, pl. 27, fig. 10) as *? Cyprina clarkei,* shows all the features of *T. plana. Tancretella plana* may be distinguished from *Fissilunula clarkei* by its greater elongation, deep pallial sinus, and its buttressed anterior adductor scar.

The hinge of the right valve illustrated by Etheridge Jnr. (1902b, pl. 10, fig. 2) does not show the 3b cardinal tooth, although it occurs in all specimens examined in the present study. Its absence from Etheridge's specimen may result from imperfect preservation.

The lectotype of *Cyprina expansa* (here designated as F 1250 Q.M. *viz* the specimen from "Maryborough" figured by Etheridge Snr. (1872, pl. 19, fig. 1) has the typical shape of *Fissilunula clarkei.* Thus the two are probably conspecific as noted by Tate (1889, p. 230) and Etheridge Jnr. (1892, p. 474).

A specimen (F 1401 G.S.Q.) from "Maryborough" figured by Etheridge Jnr. (1892, pl. 26, fig. 20) as *Ceromya* ? sp. ind. is probably a distorted *Fissilunula clarkei.*

Occurrence.—Minmi Member: RD.26; RD.207. *Fissilunula clarkei* is a widely distributed, commonly occurring species, characteristic of Australian Aptian sediments. It occurs in the Aptian Melligo Quartzite of the Dampier Peninsula of Western Australia (Brunnschweiler, 1960), and in Aptian sediments of the Great Artesian Basin in South Australia and north-west New South Wales. In Queensland *F. clarkei* is found in the Maryborough Formation

(Etheridge Jnr., 1892), in both the Minmi Member and the Roma Formation, the Blackdown Formation (Woods, 1961), and the Doncaster Member (Vine and Day, 1965). The genus has not been recognised outside Australia.

Range.—Aptian.

Superfamily ARCTICACEA
Family NEOMIODONTIDAE

Remarks.—This Jurassic to Lower Cretaceous family was proposed by Casey (1955) to receive the genera *Neomiodon, Eomiodon, Myrene, Cyrenopsis* and *Musculiopsis*. The combination of simple lucinoid cardinal teeth and long corbuloid laterals readily distinguishes the family. Casey (1955, p. 208) commented that the habitat of the family was largely in brackish or freshwater, and suggested the Neomiodontidae as the forerunner of the Corbiculidae. The time range of *Cyrenopsis* is apparently Neocomian to Albian.

Genus *Cyrenopsis* Etheridge Jnr., 1902

Type Species (by original designation).—*Mactra meeki* (= *Unicardium meeki*) Etheridge Jnr., 1892. Aptian, Queensland and South Australia.

Remarks.—Unfortunately the dentition of *Cyrenopsis* is not visible on either of the syntypes (F 1336; F 1337 G.S.Q.) from the "Walsh River", figured by Etheridge Jnr. (1892, p. 27, figs. 2; 3) as *Mactra meeki*. The dentition of the left valve was interpreted by reference to a specimen (F 2392 G.S.Q.) from the "Upper Flinders River", figured (1892, pl. 26, fig. 14) as undetermined genus (? *Unicardium*), and subsequently referred to *Cyrenopsis meeki* by Etheridge Jnr. (1902b, p. 30). That of the right value was interpreted from an illustration of the interior of *Cyrenopsis opallites* Etheridge Jnr. (1902b, pl. 5, fig. 17).

Cyrenopsis cf. *meeki* (Etheridge Jnr.), 1892
Pl. 3, figs 7–8

Synonymy.—

Cf. 1892 *Unicardium meeki* Etheridge Jnr., p. 472, pl. 27, figs. 2, 3.
Cf. 1892 *Mactra meeki* Etheridge Jnr., pl. 27, figs. 2, 3.
Cf. 1892 Undetermined genus (? *Unicardium*) Etheridge Jnr., pl. 26, figs. 13, 15.
1960 *Cyrenopsis* cf. *meeki* (Etheridge Jnr.); Day, p. 311.
1964 *Cyrenopsis* cf. *C. meeki* (Etheridge Jnr.); Day, table 3 (*pars.*).

Material.—A few rather exfoliated specimens with closed valves.

Diagnosis.—Well inflated, trigonal shaped *Cyrenopsis* with a slightly produced posterior.

Description.—Thick shelled, subtrigonal in shape; equivalve; moderately inflated; slightly inequilateral; dorsal margins arched; anterior and posterior margins bluntly rounded; ventral margins gently convex; posterior slightly produced. Umbones prominent, closer to the anterior; beaks prosogyral. Lunule not sharply delimited. Escutcheon long and narrow. Dentition not visible in these specimens. Ligament external, opisthodetic. Adductor muscle scars ovate, elongated dorso-ventrally. Pallial line entire. Ornament of fine concentric growth lines and weakly elevated, regularly spaced concentric ribs and more prominent depressions about 2 mm. apart.

Dimensions.—

	Length	Height	Inflation
F 7893 G.S.Q.	38·5	31	16+
F 9170	39	32	18
F 9179	35·5	28	..

Remarks.—Specimens from the Minmi Member are smaller and less inflated than Etheridge's types from the Walsh River, but are similar in outline. Unfortunately in both cases the hinge features are unknown.

Exfoliated specimens reveal numerous sinuous epizoan "worm" markings on the internal mould. Either the shells were already dead when host to the epizoans, or the condition was a pathological one, in which the mantle/shell region became infested.

Occurrence.—Minmi Member: L.141?; L.143; L.144?; L.150 G.S.Q. Comparable specimens also occur in the Roma and Blackdown Formations, the Doncaster Member and in the Lake Eyre district of South Australia. In the Minmi Member occurrences of the species are apparently rare.

Range.—Aptian.

Cyrenopsis balli sp. nov.
Pl. 3, figs. 9–14; text-fig. 4

Synonymy.—

1927 *Cyrenopsis* sp. nov., Whitehouse, p. 145.
1964 *Cyrenopsis* cf. *C. meeki* (Etheridge Jnr.); Day, table 3 (*pars.*).

Material.—Several internal moulds of opened and closed valves, and a few specimens retaining shell. *Holotype*: F 9161 G.S.Q.—a right valve internal mould from Damper Gully, 1 mile W. of Midcontinental Oil Well. *Paratypes*: F 9164 G.S.Q. closed valves from L.143 retaining shell; F 9171 G.S.Q. internal mould of closed valves from L.143; F 9160 G.S.Q. an internal mould of a right valve from the same locality as the holotype.

Diagnosis.—Elongately oval *Cyrenopsis* with a markedly produced posterior.

Description.—Thick shelled; elongately oval; equivalved; inequilateral; posterior markedly produced, dorsal margins gently arched; anterior and posterior margins bluntly rounded; ventral margins gently convex; postero-ventral junction subangular. Umbones slightly anterior; beaks prosogyral. Lunule not sharply defined. Escutcheon long and narrow. Hinge of right valve with two cardinal teeth; 3a stout, slightly opisthocline; 3b narrow, strongly opisthocline. Lateral teeth smooth; posterior lateral long and laminar; anterior laterals long, A I swollen posteriorly, A III forming the shell margin. Hinge of left valve not known. Ligament external, opisthodetic. Anterior adductor scars well impressed. Ornament of fine concentric growth lines, and weakly elevated, broadly spaced concentric ribs marking growth halts.

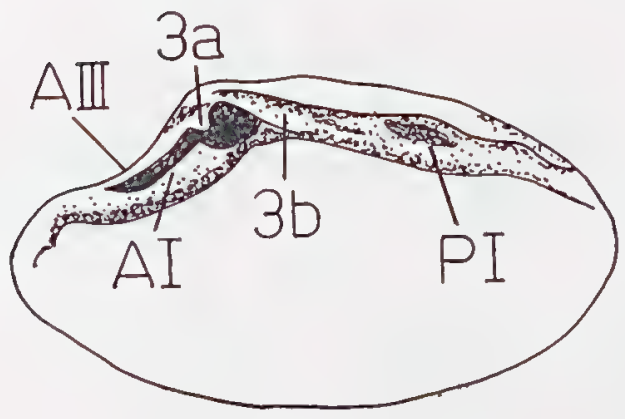

Fig. 4.

Dentition of *Cyrenopsis balli* sp. nov. Right valve, latex cast of an internal mould, holotype, x 3 (F 9161 G.S.Q.).

Dimensions (mm.).—

	Length	Height	Inflation
Holotype, F 9161 G.S.Q. . .	22	12	. .
Paratype, F 9160 G.S.Q. . .	20	12	. .
Paratype, F 9164 G.S.Q. . .	38	25	18
Paratype, F 9171 G.S.Q. . .	38	25	16

Remarks.—This species is named in recognition of the work of the late L. C. Ball who collected these specimens in the course of his pioneer work on the geology of the Roma area.

In outline *Cyrenopsis balli* resembles C. ? *elongata* Newton (1915, p. 229, pl. 6, figs. 17, 18) from White Cliffs in New South Wales, but the latter has more anterior umbones and its hinge is not known.

Occurrence.—Minmi Member: L.143; L.150 G.S.Q.; Damper Gully, 1 mile W. of Midcontinental Oil Well; Red Hill (Whitehouse, 1927).

Range.—Apparently Aptian.

Subclass PTERIOMORPHIA
Order MYTILOIDA
Superfamily MYTILACEA
Family MYTILIDAE
Genus *Inoperna* Conrad, 1875

Type Species (by subsequent designation: Popenoe, 1937, p. 382).—*Inoperna carolinensis* Conrad, 1875. Upper Cretaceous, North America.

Remarks.—This widely distributed, Middle Jurassic to Upper Cretaceous modioloid group is characterized by an ensiform shape and peculiar dorsal ornament. Cox (1940, p. 71) regarded *Inoperna* as a subgenus of *Modiolus,* whereas Wade (1926, p. 53) and Popenoe (1937, p. 382) assigned it generic rank. Since the group is a chronologically distinct one, the later course is adopted here.

Inoperna ensiformis (Etheridge Jnr.), 1902
Pl. 3, figs. 4-6

Synonymy.—
1884 *Gervillia angusta* Hudleston, p. 341, pl. 11, fig. 5 non Muenster, 1838.
1885 *Gervillia angustata* Hudleston; Tate, p. 75.
1889 *Gervilliea angusta* Hudleston; Tate, p. 230.
1902a *Gervillia angusta* Hudleston; Etheridge Jnr. p. 14.
1902a *Modiola ensiformis* Etheridge Jnr., p. 22, pl. 3, figs. 8-12.
1925 *Modiola angusta* (Hudleston); Whitehouse, p. 30.
1960 *Mytilus* n. sp. Day, p. 311.
1964 *Inoperna angusta* (Hudleston); Day, table 3.
1966 *Modiolus* (*Inoperna*) *ensiformis* (Ethridge Jnr.); Ludbrook, p. 166, pl. 20, fig. 3.

Material.—Several separated left and right valves, and a few incomplete, closed valves retaining shell.

Diagnosis.—Ensiform *Inoperna* of variable size; dorsal and ventral margins straight; carina prominent; angle of obliquity about 28 deg.; dorsal surface with an ornament of simple, non-bifurcating plicae and fine growth lines; ventral surface with fine growth lines only.

Description.—Small, ensiform in shape; dorsal and ventral margins long, straight, gradually diverging posteriorly; posterior margin rounded, making an angular junction with the ventral margin; anterior margin bluntly rounded, projecting slightly beyond the small, flattened umbones. Valves markedly carinate; angle of obliquity about 28 deg. Maximum convexity at mid-length. Hinge features and musculature not visible in this material. Surface dorsal to the carina ornamented with fine growth lines, and simple, non-bifurcating plicae which parallel the posterior margin, become sharply angled on the carina, fade, and continue as fine growth lines paralleling the ventral margin.

* *Dimensions* (mm.).—

	Length	Height	Inflation	Angle of obliquity (α) (in deg.)
F 30724 U.Q. . .	14+	10+	3·5	25
F 30725 U.Q. . .	14	8+	–	28
F 35759 U.Q. . .	9	6	–	28

* Dimensions measured after the scheme in Dickins (1963, p. 61, fig. 9).

Remarks.—Whitehouse (1925, p. 30) concluded that *Modiola ensiformis* Etheridge Jnr. (1902a) was a synonym of *Gervillia angusta* Hudleston (1884). However, Hudleston's name is preoccupied and Etheridge's name stands. Both were described from the Lake Eyre district of South Australia. *Modiolus subsolenoides* Hudleston (1890, p. 242, pl. 9, fig. 8) also from the Lake Eyre District, is somewhat similar, but is less carinate, and lacks the prominent dorsal ornament of *Inoperna ensiformis.*

The simple, non-bifurcating dorsal plicae of *I. ensiformis* indicate affinities with Jurassic and early Cretaceous species. Of these the European and Indian Bajocian-Callovian species *I. plicatus* (J. Sowerby) is quite similar, but the dorsal plicae fade before reaching the carina (see Cox, 1940, pl. 5, figs. 13-14). *Inoperna gillieroni* (Pictet and Campiche) from the Valanginian of Europe has comparable ribbing, but the figure of Gillet (1924, p. 22, text-fig. 8) shows a concave ventral margin quite unlike that of *I. ensiformis.* Upper Cretaceous species such as *Inoperna carolinensis* Conrad, *I. flagellifera* (Forbes), and *I. bellarugosa* Popenoe all have bifurcating dorsal ribs.

Occurrence.—Minmi Member: RD.78; L.318; L.2162 U.Q.; L.144; L.147; L.272 G.S.Q. The species also occurs in the overlying Roma Formation and in South Australia.

Range.—Aptian.

Genus *Eyrena* Ludbrook, 1966

Type Species (by original designation).—*Modiola linguloides* Hudleston, 1884. Aptian, Queensland and South Australia.

Remarks.—Ludbrook (1966, p. 161) proposed this generic name for thick shelled mytiliform, Australian Lower Cretaceous species which have prominent inrolled umbones like those of the Recent genus *Botula* Moerch.

The hinge line of these species, namely, *Modiola linguloides* Hudleston, *Modiola tatei* Etheridge Jnr., and *Mytilus primulafontensis* Etheridge Jnr., is considerably more thickened for ligament support than is commonly seen in living mytilids. The ligament itself was sub-external. In these features *Eyrena* resembles the Jurassic genus *Lycettia* Cox. However, the latter differs in shape and has strong longitudinal ridges on the ligament area (see Cox, 1937, pl. 17, figs. 4-6).

In the type species *Eyrena linguloides,* Ludbrook reported fine denticles on the posterior part of the hinge margin, but did not observe anterior teeth. Specimens here referred to the same species show small sub-umbonal denticles. These discrepancies may result from differences in preservation.

Eyrena linguloides (Hudleston), 1884

Pl. 4, figs. 6-13

Synonymy.—

1870 *Mytilus inflatus* Moore, p. 252, pl. 13, fig. 4 *non* Costa 1846, *nec* Mueller 1847.
1884 *Modiola linguloides* Hudleston, p. 341, pl. 11, figs. 6a, b
1885 *Modiola linguloides* Hudleston; Tate, p. 75.
1887 *Modiola linguloides* Hudleston; Tate, p. 53.
1889 *Mytilus inflatus* Moore; Tate, p. 230.
1890 *Mytilus linguloides* (Hudleston), p. 245.
1892 *Mytilus inflatus* Moore; Etheridge Jnr., p. 467, pl. 25, fig. 11.
1902a *Mytilus inflatus* Moore; Etheridge Jnr., p. 18, pl. 2, figs. 12-21.
1902a *Modiola eyrensis* Etheridge Jnr., p. 22, pl. 2, figs. 5-9.
1907 *Mytilus moorei* Cossman, p. 201, *nom. nov.* for *Mytilus inflatus* Moore.
1925 *Mytilus inflatus* Moore; Whitehouse, p. 30.
1927 *Mytilus linguloides* (Hudleston); Findlay, p. 525.
1927 *Modiola eyrensis* Etheridge Jnr.; Whitehouse, p. 145.
1964 ? *Modiolus eyrensis* Etheridge Jnr.; Day, table 3.
1964 *Mytilus tenisonwoodsi* Etheridge Jnr.; Day, table 3.
1966 *Eyrena linguloides* (Hudleston); Ludbrook, p. 162, pl. 19, figs. 1-4, 13.

Material.—Numerous internal and external moulds of separated valves and closed valves retaining shell.

Diagnosis.—Thick shelled; very inflated; mytiliform; dorsal and ventral margins long, straight, diverging widely; carina weak; angle of obliquity about 38 deg.; umbones prominent, inrolled, and twisted ventrally; hinge thickened; ligament sub-external.

Description.—Small to comparatively large in size; thick shelled; very inflated; mytiliform in shape; dorsal and ventral margins long, straight, diverging widely; posterior margin evenly rounded. Umbones prominent; inrolled and twisted ventrally. Valves weakly carinate; ventral slopes steep; angle of obliquity about 38 deg. Hinge line thickened, with a comparatively wide ligament area extending the full length of the dorsal margin; ligament attachment grooves not apparent. Ligament sub-external; closed specimens with a marked ligament gape. Anterior extremity of hinge line bearing two small sub-umbonal denticles in the right valve, and one in the left. Posterior extremity with a laminar tooth ventral to the ligament area. Anterior adductor scar elongated along the antero-ventral margin, slightly buttressed. Anterior retractor scar small, sub-circular, deeply impressed, situated within the umbonal cavity and a few mm. behind the umbo. Posterior adductor and retractor scars obscure in this material. Ornament of irregularly spaced, concentric ridges marking growth halts, and fine, concentric growth lines.

Dimensions (mm.).—

	Length	Height	Inflation	Angle of obliquity (a) (in deg.)
F 7863 G.S.Q.	41	28	22	37
F 7864 G.S.Q.	39	24	12 (1 valve)	38
F 7906 G.S.Q.	38+	26+	11 (1 valve)	35
F 7907 G.S.Q.	54	30	12 (1 valve)	34
F 7909 G.S.Q.	41+	29+	10 (1 valve)	36
F 35539 U.Q.	22	16	5 (1 valve)	38

Remarks.—Findlay (1927, p. 525) pointed out that the name *Modiola linguloides* Hudleston (1884), regarded by Tate (1889), Hudleston (1890) and Etheridge Jnr. (1892) as a synonym of *Mytilus inflatus* Moore (1870), is the first available name for this species. The replacement name *Mytilus moorei* proposed for the preoccupied *M. inflatus* by Cossman (1907, p. 201) is not required.

During preliminary examination most of the Minmi specimens were doubtfully referred to *Modiola eyrensis* Etheridge Jnr. (1902a, p. 22, pl. 2, figs. 5-9). The proportions of the single internal mould upon which this species was based are similar to those of *Eyrena linguloides.* Etheridge's species is thus interpreted as a synonym of the latter. This view is also adopted by Ludbrook (1966, p. 162).

Internal moulds from the Minmi Member which were initially identified as *Mytilus tenisonwoodsi,* are dorso-ventrally compressed. They are now regarded as distorted specimens of *E. linguloides.*

Eyrena primulafontensis (Etheridge Jnr., 1902a, pl. 2, figs. 22-24) is a similar form though smaller, with a shorter hinge line.

Another related species, *Eyrena tatei* (Etheridge Jnr., 1902a, pl. 2, figs. 10-11) has a more prominent carina and is not as expanded posteriorly as *E. linguloides.*

Occurrence.—Minmi Member: RD.78; RD.107; RD.283; RD.285; L.145; L.149; L.154; L.272 G.S.Q. The species also occurs in the overlying Roma Formation and in the Lake Eyre district of South Australia.

Range.—Aptian.

Eyrena tatei (Etheridge Jnr.), 1902

Pl. 3, figs. 1-3

Synonymy.—

1902a *Modiola tatei* Etheridge Jnr., p. 21, pl. 2, figs. 10-11.
1902b *Modiola tatei* Etheridge Jnr., p. 24, pl. 1, fig. 11.
1964 *Modiolus tatei* Etheridge Jnr.; Day, table 3.
1966 *Eyrena tatei* (Etheridge Jnr.); Ludbrook, p. 164, pl. 19, figs. 5-9.

Material.—A few internal and external moulds of separated valves and one specimen with closed valves.

Diagnosis.—Narrowly elongated; moderately inflated; carina prominent, angle of obliquity about 30 deg.

Description.—Size variable; narrowly elongated in shape; moderately inflated, a maximum at midlength; compressed posteriorly. Anterior lobe weakly developed; hinge line long, straight, half length of shell; posterior margin rounded ventrally, almost straight dorsally, meeting the hinge line at an angle of about 145 deg.; ventral margin slightly sinuate at mid-length. Umbones small, well removed from the hinge line; twisted antero-ventrally. Carina prominent; angle of obliquity about 30 deg. Hinge and ligament features obscure. Anterior adductor scar well impressed, elongated along the antero-ventral margin. Posterior adductor scar and pedal scars not visible in this material. Ornament of irregularly spaced growth ridges and fine growth lines.

Dimensions (mm.).—

	Length	Height	Inflation	Angle of obliquity (α) (in deg.)
F 30723 U.Q.	32	18	5 (1 valve)	30
F 35560 U.Q.	22	13	7 (internal mould both valves)	32

Remarks.—Minmi specimens differ from Etheridge Jnr's type from "Stuart's (formerly Cooper's) Creek, Central South Australia," only in their slightly sinuate ventral margins.

Eyrena linguloides and *E. primulafontensis* are both less carinate and more expanded posteriorly than *E. tatei.*

Occurrence.—Minmi Member: RD.6; RD.109; L.318 U.Q. The species is not as common as *Eyrena linguloides* and, in the Roma–Wallumbila area, has not been observed in the overlying Roma Formation. *E. tatei* occurs in South Australia and at White Cliffs in New South Wales. (Etheridge Jnr. 1902b).

Range.—Aptian.

Order	PTERIODA
Suborder	PTERIINA
Superfamily	PECTINACEA
Family	PECTINIDAE
Genus	*Camptonectes* Meek, 1864

Type Species (by original designation).—*Pecten lens* J. Sowerby, 1818. Jurassic (Corallian), England.

Remarks.—The genus *Camptonectes* is represented by numerous species in the Jurassic and the Cretaceous. As Whitehouse (1925) remarked, many of these are not well differentiated. Macpherson and Gabriel (1962) have referred a Recent species, *Chlamys famigerator* Iredale (1925) to *Camptonectes.* However, this species, the type of the subgenus *Talochlamys* Iredale (1929) has plicate ribs quite unlike ribbing of Jurassic and Cretaceous forms.

Camptonectes socialis (Moore), 1870

Pl. 4, figs. 1-3

Synonymy.—

1870 *Pecten socialis* Moore, p. 248, pl. 11, fig. 9.
1892 *Pecten socialis* Moore; Etheridge Jnr., p. 446, pl. 21, fig. 6 only.
1892 *Pecten* sp. ind. (? *P. socialis* or *P. psila* Tenison Woods); Etheridge Jnr., pl. 21, fig. 5.
1901 *Pecten socialis* Moore; Etheridge Jnr., p. 13, (*pars.*)
1925 *Pecten* (*Camptonectes*) *socialis* (Moore); Whitehouse, p. 28.
1927 *Pecten* (*Camptonectes*) sp. Whitehouse, p. 145.
1961 *Syncyclonema socialis* (Moore); Woods, p. 6.
1964 *Camptonectes socialis* (Moore); Day, table 3.
1966 *Camptonectes socialis* (Moore), Ludbrook, p. 159, pl. 16, figs. 7, 9, 10.

Material.—A few poorly preserved right and left valves.

Diagnosis.—Suborbicular, slightly inequivalved *Camptonectes* of small to medium size; ornament on anterior ear of right valve growth lamellae only; posterior ear of right valve with fine radiating ribs, which meet the dorsal margin at an angle of 15 degs.

Description.—Suborbicular; mostly medium sized; weakly inflated and slightly inequivalved; left valve the more convex; subequilateral, with the body of the shell expanded anteriorly; dorsal margin straight, about half width of shell. Auricles unequal, posterior the larger, sharply defined; lines of junction with body of shell making an angle of approximately 95 deg. at the umbo; anterior auricle of the right valve elongately triangular, separated from the body of the shell by a deep sulcus; posterior auricles triangular. Ornament of the body of the shell fine radiating costae and concentric growth lamellae. Anterior auricle of the right valve with raised growth lamellae, which parallel its anterior extremity. Posterior auricle of the right valve with raised growth lamellae parallel to the posterior margin of the ear, and fine radiating ribs which meet the dorsal margin at an angle of 15 degs. Ornament of auricles of the left valve not known.

Dimensions (mm.).—

	Length	Height	Inflation
F 9185 G.S.Q. . .	37	38	14
F 30505 U.Q. . .	30+	28+	–
F 35741 U.Q. . .	34	34	3 est. (right valve)

Remarks.—The specimen from "Wollumbilla" figured by Moore (1870, pl. 11, fig. 9) as *Pecten socialis* was apparently a decorticated left valve. As remarked by Etheridge Jnr. (1901) this has made

identification difficult. Comparison with topotypes has shown that specimens from the Minmi Member have similar ornament on the auricle of the right valve They are therefore referred to *Camptonectes socialis*. The specimen (F 1284 G.S.Q.) from a bore at Mitchell Railway Station (Aptian, Roma Formation) figured by Etheridge Jnr. (1892, pl. 21, fig. 5) is conspecific.

Etheridge Jnr. (1901) considered the species a variable one, particularly with regard to ornament. However, an examination of specimens figured from the Albian localities of Aramac and Rockwood Station by Etheridge Jnr. (1892, pl. 21, figs. 7, 8, 9) and referred to *Pecten socialis* by him in 1901, has revealed these to be a distinct species. They differ from the Aptian *Camptonectes socialis* in their more equilateral shape, and in their cancellate and comparatively coarse radial ornament on the body of the shell.

The specimen figured by Etheridge (1902a, pl. 1, figs. 11, 12) as *Syncyclonema ? socialis,* appears to have a crenulate interior margin and may not be conspecific.

Camptonectes socialis differs from the type species *C. lens* principally in the direction of the radial ribs on the posterior auricle of the right valve. In *C. lens* these meet the dorsal margin at an angle of 50-60 degs. (see Arkell, 1928, p. 97, text-fig. 19, pl. 7, fig. 1; 1929, pl. 9, figs. 4-7).

Whitehouse (1925) cited *Camptonectes projectus* (Tate) from the Neocomian Uitenhage beds of South Africa, *C. striatopunctatus* (Roemer) from the Lower Cretaceous of Europe, and the European Upper Cretaceous *C. curvatus* (Geinitz) as similar species. However, none are stritcly comparable.

Occurrence.—Minmi Member: RD.109; L.143; L.150 G.S.Q.; L.319, L.2162 U.Q.; Red Hill (Whitehouse, 1927). The species also occurs in the Roma and Blackdown Formations, the Doncaster Member of the Wilgunya Formation and in South Australia.

Range.—Aptian.

Family AVICULOPECTINIDAE
Subfamily OXYTOMINAE

Remarks.—Cox (1962) elevates the subfamily Oxytominae Ichikawa (1958), proposed for the genera *Oxytoma, Meleagrinella* and *Maccoyella,* to family rank, and apparently includes *Pseudavicula* in addition. However, the group is retained here as a subfamily, enabling the relationship with the Aviculopectinidae to be shown.

Genus *Meleagrinella* Whitfield, 1885

Type Species (by subsequent designation: Etheridge Jnr., 1892, p. 453).—*Avicula curta* Hall, 1852. Jurassic, U.S.A.

Remarks.—*Avicula curta* was also selected as type species by Cox (1941, p. 134). According to Cox the differences between *Avicula curta* and *Avicula echinata* Wm Smith (the type species of *Echinotis* Marwick, 1935) are slight, and consequently he regarded *Echinotis* as a synonym of *Meleagrinella.* This view has gained general acceptance, though it has been questioned by Brunnschweiler (1960).

Meleagrinella woodsi sp. nov.
Pl. 5, figs. 5-15

Synonymy.—

1927 *Coilotis lens* gen. & sp. nov. Whitehouse, p. 145, 146. (*nom. nud.*).
1960 *Pseudavicula papyracea* Etheridge Jnr.; Day, p. 311.
1964 *Pseudavicula* sp. (= *Coilotis lens* Whitehouse, 1927); Day, p. 14, table 3.

Material.—Numerous specimens, many of which retain their shell material.

Holotype.—F 35510 U.Q.—a partly exfoliated left valve showing hinge features (RD.99); *Paratypes.*—Left valves—F 7910, F 7913, G.S.Q. (L.153), F 35623 U.Q. (L.2162); right valves—F 28848 U.Q. (L.318), F 35666 U.Q. (RD.99).

Diagnosis.—Acline, erectly ovate *Meleagrinella,* with fairly short hinge line, and ornamented with rather sparse, often faint, radial ribs and subordinate, imbricate, concentric lamellae on left valves, with mainly concentric ornament on the right.

Description.—Shell shape erectly oval, higher than long; acline; markedly inequivalved; left valve very convex at midlength, and with a variably developed postero-ventral sulcus; right valve weakly inflated; hinge line shorter than shell length; umbones of left valves prominent acline, subcentral; posterior ears not sharply defined, without emargination; anterior ear of left valve crenulate, each ridge marking a growth stage; anterior ear of right valve very prominent, projecting upwards and inwards; subauriclar notch very deep; postero-ventral sulcus variably developed in both valves, hinge plate of left valve fairly narrow; ligament pit occupying posterior portion, deepest anteriorly, where it is bounded by a strong, opistho-cline ridge originating at the umbo; below and just in front of the umbo there is a bulbous, tooth-like, thickening, and immediately anterior to this there is a small recess ("gelenkgrube"). Hinge of right valve and musculature not known. Left valves ornamented with up to 25 broad radial ribs, not differentiated into primaries and secondaries, often faint; crossed by fine, subordinate, imbricate, concentric lamellae. Right valves ornamented with very faint radial lines and more conspicuous concentric lamellae.

Dimensions (mm.).—

	Length	Height	Inflation
LEFT VALVES—			
Holotype F 35510 U.Q. . .	26	26+	7
Paratype F 35623 U.Q. . .	25	26	6
Paratype F 7910 G.S.Q. . .	18	21	6
Paratype F 7913	14	16	4
RIGHT VALVES—			
Paratype F 28848 U.Q.	16 (approx.)	18	2
Paratype F 35666 U.Q. . .	17	18	2

Remarks.—This species is named after Mr. J. T. Woods, Director of the Queensland Museum, for his contributions to Queensland palaeontology. Some difficulty was experienced in identification of this shell, which is very characteristic of the Minmi Member. Initial reference to *Pseudavicula papyracea* was based on exfoliated specimens; the later reference to *Pseudavicula* sp. was made without adequate knowledge of the hinge.

Meleagrinella woodsi is apparently the species referred to as *Coilotis lens* gen. & sp. nov. by Whitehouse (1927) for paratype F 28848 U.Q. was originally labelled so by him. *Coilotis lens* was never described and is a *nomen nudum.*

Pseudomonotis supertes Spitz (1914, pl. 18, figs. 6, 7) from the Guiemal Sandstone of India is very similar in shape, and apparently also in ornament, though this is less certain as Spitz's figures are restored.

Meleagrinella cf. *M. superstes* figured by Brunnschweiler (1960, pl. 1, figs. 20, 22, 25, 26, text-fig. 15) from the Neocomian of Dampier Peninsula is more orbicular (*ie.* not as high as *M. woodsi*). It is closer to *Pseudomonotis* sp. Whitehouse (1946, pl. 1, figs. 7, 8) and *Meleagrinella* sp. described below.

Undescribed forms reported by Woods (1963a, b) from the Neocomian of the Laura Basin are also similar, but are probably not conspecific. Skwarko (1966, p. 80, pl. 5, figs. 1–5) has since described as *Pseudavicula dickinsi,* a *Meleagrinella* closely allied to *M. woodsi* but possessing more radial costae.

The hinge of the left valve of *M. woodsi* is almost identical with that of *M. echinata* figured by Pompeckj (1901, pl. 15, figs. 15, 19). However, this Jurassic species is multicostate and has an emarginate posterior ear.

Pseudavicula anomala, which has somewhat similar ornament, can be distinguished by its almost terminal umbones and its weakly inflated valves which are almost of equal convexity. In addition, in the left valve the hinge plate narrows rapidly at the anterior end of the ligament pit, and there is no trace of the bulbous tooth-like thickening and gelenkgrube so well developed in *Meleagrinella.*

Occurrence.—*Meleagrinella woodsi* is at present known only from the Minmi Member. Whitehouse (1927) reported it (as *Coilotis lens*) from Red Hill, Clerk Creek Crossing, State Farm Well, Murray's Well (80 ft). RD.6; RD.78; RD.82; RD.94; RD.97; RD.99; RD.109; RD.283; L.318; L.2162 U.Q.; L.143; L.147; L.148; L.151; L.152; L.153 G.S.Q.

Range.—Apparently Aptian.

Meleagrinella sp.
Pl. 5, figs. 16-17

Synonymy.—
1964 *"Pseudomonotis"* sp. (= *Pseudomonotis* sp. Whitehouse, 1946); Day, p. 14, table 3.

Material.—A single somewhat abraded left valve.

Description.—Shell small, orbicular, convex, umbo slightly anterior of midline; anterior ear crenulate; posterior ear incomplete, comparatively large, sharply defined; hinge not visible; ornament of about 15 fine primary radial ribs with intercalated secondary ribs near the midline, and fine concentric lamellae.

Dimensions (mm.).—

	Length	Height	Inflation
F 7842 G.S.Q.	15	15	5

Remarks.—This shell closely resembles that figured by Whitehouse (1946, pl. 1, figs. 7, 8) from Neocomian sediments near Stanwell, but is a little more convex.

Meleagrinella cf. *M. superstes* figured by Brunnschweiler (1960, pl. 1, figs. 20, 22, 25, 26, text-fig. 15) from the Neocomian of Dampier Peninsula, is also similar.

Occurrence.—L.134 associated with the plant fossil *Elatocladus planus* (Feistmantel).

Range.—Neocomian ? – Aptian.

Genus *Maccoyella* Etheridge Jnr., 1892
(Synonym—*Mimetostreon* Bonarelli 1921)

Type Species (by original designation).—*Avicula barklyi* Moore, 1870. Aptian, Queensland, South Australia and New South Wales.

Remarks.—*Mimetostreon* Bonarelli (1921), proposed as a sub-genus of *Gryphaea,* is a subjective synonym of *Maccoyella,* as the type species by original designation, *Avicula corbiensis* Moore (1870) is a *Maccoyella.* However, the name might be retained as a subgenus for the gryphaeoid group of *Maccoyella* typified by *M. corbiensis.*

Maccoyella barklyi (Moore), 1870
Pl. 5, figs. 18-19; pl. 6, figs. 4-7

Synonymy.—
1870 *Avicula barklyi* Moore, p. 245, pl. 11, figs. 1, 2.
1872 *Streptorhynchus davidsoni* Etheridge Snr., p. 333, pl. 17, fig. 1.
1880 *Monotis barklyi* (Moore); Tate, p. 104.
1882 *Avicula barklyi* Moore; Tate, p. 149.
1885 *Monotis barklyi* (Moore); Tate, p. 76.
1887 *Monotis barklyi* (Moore); Tate, p. 53.
1889 *Avicula barklyi* Moore; Tate, p. 230.
1892 *Maccoyella barklyi* (Moore); Etheridge Jnr., p. 455, pl. 22, figs. 1, 2, 4, 5.
1892 *Maccoyella reflecta* (Moore); Etheridge Jnr., pl. 23, figs. 1 and 2 only.
1892 *Maccoyella barklyi* (Moore) var. *mariaeburiensis* Etheridge Jnr., p. 563, pl. 22, fig. 3; pl. 42, figs. 4-6.
1901 *Avicula barklyi* Moore; Guerich, p. 484.
1902a *Maccoyella barklyi* (Moore); Etheridge Jnr., p. 11, pl. 1, figs. 3-6.
1902b *Maccoyella barklyi* (Moore); Etheridge Jnr., p. 17, pl. 1, figs. 3, 4; pl. 2, figs. 3-5; pl. 3, figs. 4, 5; pl. 4, figs. 3, 4.
1915 *Maccoyella barklyi* (Moore); Newton, p. 225, pl. 6, fig. 19.
1925 *Maccoyella barklyi* (Moore); Whitehouse, p. 28.
1927 *Maccoyella barklyi* (Moore); Whitehouse, p. 145, 146.
1928 *Maccoyella barklyi* (Moore); Whitehouse, p. 276.
1960 *Maccoyella barklyi* (Moore); Day, p. 311.
1964 *Maccoyella barklyi* (Moore); Day, p. 17, 18, table 3.
1966 *Maccoyella barklyi* (Moore); Ludbrook, p. 150, pl. 15, figs. 1-7.

Material.—Several left valves, a few right valves and a few fragmentary specimens with closed valves.

Diagnosis.—Thick shelled, pectinoid shaped *Maccoyella*; left valve posterior ear small, hinge line much shorter than shell length; radial ribs of left valve coarse, frequently spinose, well differentiated into primary and secondary orders; larger specimens with intercalated tertiary and quaternary ribs; radial ribs of right valve finer and more numerous.

Description.—Shape pectinoid, higher than long, shell thick; inequivalve, left valve convex, right valve flattened; hinge margin shorter than shell length; anterior and posterior dorsal margins making an angle of about 120 deg. at the umbo; umbo of left valve subcentral, prominent, rising above hinge line; that of right valve small and inconspicuous; anterior ear of left valve very crenulated; that of right valve large, thick, with a median depression, subauricular notch wide and deep; posterior ears not sharply defined, that of left valve smaller than the right; left valve with variably developed postero-ventral sulcus. Hinge plate wide; ligament pit longitudinally grooved. In left valves ligament pit is bounded anteriorly by a low, slightly opisthocline ridge originating at the umbo; posterior termination a weak, very opisthocline ridge. Immediately anterior to the umbo the lower margin of hinge plate has a knob-like tooth flanked by depressions; the tooth articulates with the median socket of the right valve anterior ear. Right valve hinges not exposed in this material. Each valve with a subcentral, suboval, adductor muscle scar, and usually a row of pits marking the pallial line. Radial ornament of left valve in three distinct orders; approximately 12 prominent, primary ribs, with secondary ribs in the interspaces; tertiary ribs appear near the midline at a height of 20 mm.; no quaternary ribs observed in these specimens. Radial ribbing frequently discrepant after marked growth halts. Concentric ornament of left valve fine, closely spaced lamellae, and prominent, concentric ridges, 3–5 mm. apart, tending to be spinose where they cross the radial ribs. Right valve with at least 20 fine primary radial ribs, secondary and occasional tertiary ribs in the interspaces; crossed by fine, close-set concentric lamellae and broadly spaced concentric depressions marking growth halts.

Dimensions (mm.).—

	Length	Height	Inflation
LEFT VALVE—			
F 35737 A/B U.Q. ..	83	80	15
RIGHT VALVE—			
F 9189 G.S.Q.	55	48	4

Remarks.—*Maccoyella reflecta* (Moore, 1870, pl. 12, fig. 1) from "Wollumbilla" (Roma Formation), is also pectinoid in shape, but differs from *M. barklyi* in its greater posterior alation and finer radial ribbing on the left valve.

Primary radial ribbing on left valves varies somewhat in strength. Specimens in which it was very strongly developed and spinose were given the varietal name *mariaeburiensis* by Etheridge (1892).

The development of tertiary and quaternary radial ribs has been studied in a large number of specimens which include those used by Whitehouse (1927). In none of these were teritary ribs developed before a height of 20 mm. was attained, while quaternary ribs were rarely observed in shells less than 40 mm. high. From this it is concluded that the interpolation of tertiary and quaternary ribs is a function of increasing size, not a mutant condition as Whitehouse (1928) thought. In any case, the premise that the rib development was of biostratigraphic significance in this area (Whitehouse, 1927) is untenable, as tertiary ribbed specimens, including one figured here, occur in the oldest marine sediments (Minmi Member). Specimens examined by Whitehouse (1927) from two localities in the Minmi Member are not well preserved.

Occurrence.—Minmi Member: RD.78; RD.94?; RD.99; RD.107; RD.207?; RD.285?; L.139; L.140; L.141; L.272 G.S.Q. portion 13, parish Euthulla; portion 131v, parish of Bungeworgorai (Whitehouse, 1927). *Maccoyella barklyi* is a widely distributed characteristically Aptian species. It occurs in the Maryborough Formation, the Blackdown Formation and the Wrotham Park Sandstone (Woods, 1961), in the Doncaster Member of the Wilgunya Formation (Vine & Day, 1965), in the Minmi Member and the Roma Formation, and in the South Australian and New South Wales extensions of the Great Artesian Basin (Etheridge, 1902a, b).

Range.—Aptian.

Maccoyella subangularis Etheridge Jnr., 1892
Pl. 5, figs. 1-3

Synonymy.—

1870 *Avicula substriata* Moore, p. 247, pl. 11, fig. 6, *non* Zeiten, 1830.
1892 *Maccoyella ? substriata* (Moore); Etheridge Jnr., p. 459, pl. 22, fig. 10 only.
1892 *Maccoyella subangularis* Etheridge Jnr., p. 460.
1901 *Maccoyella substriata* (Moore); Etheridge Jnr., p. 19, pl. 3, fig. 5, pl. 4, fig.4.
1901 *Maccoyella ? subangularis* Etheridge Jnr., p. 19.
1902a *Maccoyella barklyi* (Moore); Etheridge Jnr., pl. 1, fig. 7 only.
1927 *Maccoyella substriata* (Moore); Whitehouse, p. 146.
1964 *Maccoyella subangularis* Etheridge Jnr.; Day, table 3.

Material.—One ventrally incomplete left valve showing hinge features; one posteriorly incomplete external mould of a left valve and one internal and external mould of a right valve.

Diagnosis.—Small, thin shelled, pectinoid *Maccoyella* with an extended posterior wing.

Description.—Small; thin shelled; somewhat elongate-oblong in shape, length greater than height; inequilateral; inequivalve, left valve more convex than the right; dorsal margin long almost straight; ventral and anterior margins gently convex; posterior margin obliquely truncated. Umbo of left valve prominent, orthocline, overhanging the hinge line; situated near the anterior extremity of the hinge line. Umbo of right valve insignificant. Left valve anterior ear small, slightly crenulated; anterior ear of right valve small, with a small sub-auricular notch. Posterior ears of

both valves large, extended, with little or no emargination. Hinge of left valve with narrow hinge plate bearing a small knob-like subumbonal tooth, flanked by shallow sockets. Ligament pit long, narrow, bearing a few, fine, longitudinal ridges; bounded anteriorly by a slightly opisthocline transverse ridge; narrowing posteriorly and terminated by a faint, very acline ridge. Hinge of right valve and musculature not visible in these specimens. Right valve with numerous, very fine radial ribs which are not differentiated into orders, and fine concentric growth lines. Left valve with about 9 primary radial ribs, with intercalated secondary, tertiary and possibly quaternary ribs, and fine, imbricate concentric growth lamellae.

Dimensions (mm.).—

	Length	Height	Inflation
F 7843 G.S.Q. ..	25	19·5	2 (right valve)
F 35536 U.Q. ..	25+	22	5 (left valve)

Remarks.—Maccoyella subangularis, a name applied by Etheridge Jnr. (1892, p. 460) to an unfigured specimen collected from "Bungeworgorai Creek near Mt. Abundance" by George Sweet, was listed (1901, p. 19) as a synonym of *Avicula substriata* Moore. As Moore's name is preoccupied, Etheridge's becomes the first available.

The hinge of the left valve of *Maccoyella subangularis* is very like that of *Meleagrinella,* but the knob-like *Maccoyella* "tooth" is more developed.

Occurrence.—Minmi Member: RD.6; RD.26; RD.109?; RD.128; L 2162 U.Q. por. 115v, par.; Bungeworgorai (Whitehouse, 1927). The species also occurs in the Roma and Maryborough Formations (Etheridge Jnr., 1892).

Range.—Aptian.

Genus *Pseudavicula* Etheridge Jnr., 1892

Type Species (by original designation).—*Lucina anomala* Moore, 1870. Aptian, Queensland and South Australia.

Pseudavicula anomala (Moore), 1870
Pl. 5, fig. 4

Synonymy.—

1870 *Lucina anomala* Moore, p. 251, pl. 14, fig. 4.
1870 *Lucina ? australis* Moore, p. 251, pl. 14, fig. 5.
1884 *Avicula orbicularis* Hudleston, p. 341, pl. 11, fig. 11.
1885 *Avicula orbicularis* Hudleston; Tate, p. 76.
1890 *Pseudavicula anomala* (Moore); Hudleston, p. 244.
1892 *Pseudavicula anomala* (Moore); Etheridge Jnr. p. 450, pl. 24, figs. 6, 8, 11.
1892 *Pseudavicula australis* (Moore); Etheridge Jnr., p. 451, pl. 24, figs. 7, 9, 10, 12, 13.
1902a *Pseudavicula australis* (Moore); Etheridge Jnr., p. 15, pl. 2, fig. 2.
1902a *Pseudavicula anomala* (Moore); Etheridge Jnr., p. 16, pl. 2, fig. 1.
1902b *Pseudavicula anomala* (Moore); Etheridge Jnr., p. 15, pl. 7, fig. 11, pl. 10, fig. 4.
1925 *Pseudavicula anomala* (Moore); Whitehouse, p. 27, pl. 1, figs. 1, 2, 3.
1927 *Lucina anomala* Moore: Findlay, p. 529.
1961 *Pseudavicula australis* (Moore); Woods, p. 6.
1964 *Pseudavicula anomala* (Moore); Day, table 3, p. 17-18.
1966 *Pseudavicula anomala* (Moore); Ludbrook, p. 153, pl. 16, figs. 1-4.

Material.—Numerous, small, frequently exfoliated, separated right and left valves and a few specimens with closed valves.

Diagnosis.—Meleagriniform shaped *Pseudavicula,* with a somewhat reticulate ornament of numerous, close, radial costae, and finer concentric growth lamellae.

Description.—Thin shelled, nacreous; size variable; shape meleagriniform, height greater than length; inequilateral; slightly inequivalve, the left valve more convex than the right; postero-dorsal margin straight, equal to about half the shell length; other margins gently convex. Umbones anterior, higher in the left valve than in the right. Anterior ear not developed in the left valve; small and commonly not preserved in the right. Posterior ears well developed, with little emargination, their boundary with the body of the shell indistinct. Hinge features not visible in this material. Adductor scars subcentral; suboval; with crescentic markings. Exfoliated surfaces smooth, shining; exterior with numerous fine radial costae and finer concentric growth lamellae.

Dimensions (mm.).—

	Length	Height	Inflation
F 7998 G.S.Q. ..	10	12	3 (left valve)
F 9176 G.S.Q. ..	7	9	1·5 (right valve)
F 9177 G.S.Q. ..	8	9	1·5 (right valve)
F 9178 G.S.Q. ..	10	11	2 (right valve)

Remarks.—Specimens from the Minmi Member in the Roma-Wallumbilla area do not appear to be conspecific with those described by Dickins (1960a) from the "south-west corner of portion 53v, parish of Bendemere, left bank of Yuleba Creek." This locality is several miles east of the area mapped by Day (1964), but probably lies within the Minmi Member. Specimens figured by Dickins (1960a, pl. 63, figs. 1-5) clearly show the musculature, hinge features and anterior ear of the right valve. As the development of radial ribbing was apparently variable in the Yuleba specimens, Dickins compared them with the Albian species *Pseudavicula papyracea* Etheridge Jnr. (1907), but they probably represent a distinct species.

As noted by Etheridge Jnr. (1907, p. 320) and Dickins (1960a, p. 393) *P. papyracea* lacks the strong exterior radial ribbing of *P. anomala.* Even though the ornament of *P. anomala* varies from almost smooth to reticulate, depending on the degree of exfoliation, the species can be distinguished from *P. papyracea* by the more deeply impressed muscle scars, and proportionately smaller anterior ear. In addition *P. papyracea* is generally smaller, thinner shelled and less biconvex.

In outline, and to a certain extent in ornament, *Pseudavicula anomala* resembles *Meleagrinella woodsi* n. sp., but the latter is markedly inequivalved, and has much more inflated left valves than *P. anomala.* The hinge features of the two are also quite distinct.

Occurrence.—Minmi Member: RD.78; RD.98; RD.107; RD.109; ?RD.301; L.144; L.146; L.269; L.272 G.S.Q.; L.2162 U.Q. The species, which is characteristic of the Aptian stage in Australia, also

occurs in the Roma, Blackdown and Maryborough Formations, the Doncaster Member of the Wilgunya Formation, in South Australia and north-west New South Wales.

Range.—Aptian.

Subclass	ANOMALODESMATA
Order	PHOLADOMYOIDA
Superfamily	LATERNULACEA
Family	LATERNULIDAE
Genus	*Periplomya* Conrad, 1870

Type Species.—Periploma applicata Conrad, 1860. Cretaceous, North America.

Remarks.—Periplomya Conrad (1870, p. 76), a new name for the pre-occupied *Leptomya* Conrad (1867, p. 15), has two months priority over the replacement name *Plicomya* Stoliczka (1870, p. 69). The type species is apparently *Periplomya applicata* Conrad. *P. peculiaris* cited as type by Stolickza (1870, p. xvi) was not included in Conrad's original list.

Periplomya cf. *robinaldina* (d'Orbigny) 1845
Pl. 2, figs. 7-9

Synonymy.—

Cf. 1909 *Thracia robinaldina* ? (d'Orbigny); Woods, p. 242, pl. 40, figs. 1-3.
1927, *Thracia* ? sp. Whitehouse, p. 146.
1964 *Thracia* sp. aff. *T. robinaldina* (d'Orbigny); Day, table 3.

Material.—Several separated right and left valves retaining shell, and a few internal and external moulds.

Diagnosis.—Elongately oval *Periplomya* with a straight postero-dorsal margin, gently truncate posterior, and a weakly impressed carina.

Description.—Small to medium in size; shell thin; elongately oval; length 1·5 times height; somewhat compressed; slightly inequivalve and inequilateral. Anterior and ventral margins gently convex; posterior dorsal margin straight; posterior narrowed and gently truncate, gaping slightly. Umbones prominent, closer to the anterior; beaks opisthogryal. Escutcheon well developed; lunule small. Anterior carina weakly impressed. Hinge features not fully known. Left valve with a long lamellar tooth paralleling the antero-dorsal margin and articulating with a groove in the anterior margin of the right valve. Musculature obscure. Ornament of fine growth lines and a few, irregularly spaced concentric ridges.

Dimensions (mm.).—

	Length	Height	Inflation
F 9182 G.S.Q.	17	11·5	3 (1 valve)
F 30490 (A) U.Q. ..	34	24·5	6 (1 valve)
F 30491 U.Q.	39	26	5 (1 valve)

Remarks.—In shape the Minmi specimens compare closely with those figured by Woods (1909) from the Lower Greensand as *Thracia robinaldina*?. Unfortunately neither group shows hinge features. Casey (1961, p. 607) reported the English specimens as *Periplomya robinaldina* (d'Orbigny) and gave their range as *fissicostatus* and *forbesi* zones *ie.* lowest Lower Aptian. d'Orbigny's species was among those originally included in the genus *Periplomya* (=*Leptomya* Conrad not Adams) by Conrad (1867).

Thracia wilsoni Moore (1870, pl. 14, fig. 8) is somewhat similar but is a larger, proportionately higher species.

Occurrence.—Minmi Member: RD.109; L.150; G.S.Q.; L.2162 U.Q.; portion 131v, parish Bungeworgorai (Whitehouse, 1927).

Range.—Aptian.

Family	THRACIIDAE
Genus	*Thracia* (Leach ms.) de Blainville, 1824

Type Species (by subsequent designation Blainville, 1827, p. 660).—*Thracia corbuloidea* Blainville, 1824. Recent, Mediterranean Sea.

Remarks.—Thracia primula has an external ligament recalling species of the Recent Australian genus *Eximothracia* Iredale (1924), rather than living species of *Thracia* in which ligament is largely internal. However, until more and better preserved material is available, the species is retained in *Thracia.*

Thracia primula Hudleston, 1890
Pl. 4, figs. 4-5

Synonymy.—

1890 *Thracia primula* Hudleston, p. 245, pl. 9, fig. 7.
1892 *Corimya primula* ? (Hudleston); Etheridge Jnr., p. 481, pl. 28, fig. 11.
1902a *Corimya* ? *primula* (Hudleston); Etheridge Jnr., p. 36.
1902b *Corimya* ? *primula* (Hudleston); Etheridge Jnr., p. 38, pl. 3, figs. 8, 9.
1925 *Thracia primula* Hudleston; Whitehouse, p. 31, pl. 1, fig. 5.
1964 *Thracia primula* ? Hudleston; Day, table 3.

Material.—One specimen with both valves in apposition; one internal mould of a right valve; external moulds of left valves.

Diagnosis.—Elongately oval, weakly inflated *Thracia* with sloping postero-dorsal margin; umbones slightly posterior, not prominent; carina distinct.

Description.—Shell thin, elongately oval; weakly inflated; right valve slightly larger and more inflated than the left; anterior rounded; posterior obliquely truncate; postero-dorsal margin sloping. Umbones slightly posterior, opisthogyral, not prominent; carina from umbo to postero-ventral margin very distinct. Hinge apparently without teeth; ligament external, opisthodetic. Musculature and pallial characters not visible in this material. Ornament consists of irregularly spaced broad concentric ribs and fine concentric growth lines.

Dimensions (mm.).—

	Length	Height	Inflation
F 1341 G.S.Q.	59	52	4 (1 valve)
F 7841 G.S.Q.	43	34	9

Remarks.—*Thracia primula* resembles *T. wilsoni* Moore (1870, p. 254, pl. 14, fig. 8) but is more compressed, is distinctly carinate and has less prominent umbones. *T. primula* is also more transversely elongate than *T. wilsoni.*

Whitehouse (1925, p. 31) cited *Thracia* sp. (Kitchin, 1913, pl. 8, fig. 5) from the Neocomian Uitenhage Beds of South Africa as a similar species, but remarked that the genus is one of limited variation and species from many horizons might be compared.

Occurrence.—Minmi Member: RD.26; RD.207; ?RD.283; Clerk Ck., 1½ miles below junction with Bindango Ck. *Thracia primula* is apparently a rare species. It was originally described from Primrose Springs in South Australia (Hudleston, 1890). Etheridge Jnr. (1892) figured a specimen from Minmi near Roma (Minmi Member) and later (1902b) reported the species from two localities in north-west New South Wales. A very similar form has recently been observed in Albian sediments of the Longreach area. In the Roma–Wallumbilla area the species has only been found in the Minmi Member.

Range—Aptian–Albian?

Family HAITELLIDAE (Saxicavidae)
Genus *Panopea* Menard de la Groye, 1807

Type Species (by monotypy).—*Panopea aldrovandi* Menard de la Groye, 1807 (= *Mya glycymeris* Born, 1780). Recent, Mediterranean Sea.

Panopea maccoyi (Moore), 1870
Pl. 6, figs. 1-3; text fig. 5

Synonymy.—

1870 *Mya maccoyi* Moore, p. 253, pl. 13, fig. 8.
1889 *Myacites m'coyii* (Moore); Tate, p. 230.
1892 *Glycimeris* ? *maccoyi* (Moore); Etheridge Jnr., p. 480.
1892 *Glycimeris* sp. ind. Etheridge Jnr., pl. 28, fig. 6.
1901 *Glycimeris* ? *maccoyi* (Moore); Etheridge Jnr., p. 30.
1902a *Glycimeris maccoyi* (Moore); Etheridge Jnr., p. 38, pl. 4, figs. 10, 11
1964 *Panopea rugosa* (Moore); Day, table 3 (*pars.*).
1966 *Panopea maccoyi* (Moore); Ludbrook, p. 170, pl. 21, fig. 3, pl. 22, figs. 1-5.

Material.—A few internal moulds with both valves in apposition and several internal and external moulds of left valves.

Diagnosis.—Transversely elongate *Panopea,* with anterior umbones, no frontal gape and an ornament of strong, irregularly spaced concentric ribs.

Description.—Transversely elongate; equivalve, maximum inflation immediately anterior to the umbones; anterior truncate, closed; posterior somewhat attenuated, gaping; ventral margin very gently convex; hinge line long, weakly arched. Umbones broad, situated in anterior third of shell. Variably developed carina extends from the umbo to the antero-ventral margin. Lunule and escutcheon fairly well defined. Hinge with a single conical tooth in each valve, that of the right placed anterior to that of the left. Ligament external, opisthodetic. Musculature and pallial line not visible in this material. Ornament of irregularly spaced, strong concentric ribs which fade posteriorly, and fine growth lines.

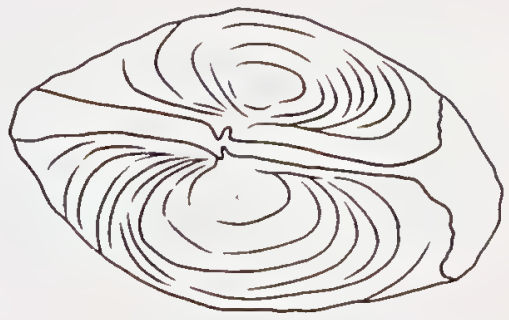

FIG. 5.
Detention of *Panopea maccoyi* (Moore). Internal mould of slightly displaced valves, x 1 (F 9174 G.S.Q.).

Dimensions (mm.).—

	Length	Height	Inflation
F 35514 U.Q.	55	32	7 (1 valve)
F 1329 G.S.Q.	62	38	10 (1 valve)
F 9174 G.S.Q.	45+	34	26
F 9175 G.S.Q.	45	30	22

Remarks.—*Panopea maccoyi* (Moore) is distinguished from *Panopea moorei nom. nov.* for *Panopea rugosa* Moore (1870, p. 253, pl. 13, fig. 7) *non* Keyserling 1846, *nec* d'Orbigny 1850, by its anterior umbones. The present specimens are to some extent intermediates, and during preliminary examination were referred to the latter species. The specimen (F 1329 G.S.Q.) from "Minmi near Roma" figured by Etheridge Jnr. (1892, pl. 28, fig. 6) as *Glycimeris* sp. ind. is conspecific. The original illustration is misleading and the specimen is refigured here (pl. 6, fig. 1).

Specimens found in place at right angles to the bedding seem to have been distorted by compaction. They display very prominent carinas extending from the umbo to the antero-ventral junction, and appear to have been shortened anteriorly.

Occurrence.—Minmi Member: RD.39; RD.78; RD.107; RD.128; RD.283; Minmi near Roma (Etheridge Jnr., 1892); Clerk's Creek, 1 mile below the junction of Bindango Creek. Originally described from "between Amby and Maranoa Rivers" (Moore 1870), a locality probably in the Roma Formation, *Panopea maccoyi* was subsequently reported from Maryborough (Etheridge Jnr., 1901) and South Australia (Etheridge Jnr., 1902; Ludbrook, in press).

Range.—Aptian.

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APPENDIX

FOSSIL LOCALITIES IN THE MINMI MEMBER ROMA–WALLUMBILLA AREA

GEOLOGICAL SURVEY OF QUEENSLAND COLLECTIONS

L.101 Near Warooby Ck, about ¾ mile ENE. of the SE. corner of portion 26v, parish of Beaufort.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.134 Sleepy Ck, about ¾ mile up the creek from the SW. corner of portion 56, parish of Blythdale.
Collection.—C. H. W. Thom, 1913.

L.139 Earth tank excavated on portion 13, parish of Euthulla.
Collection.—L. C. Ball, 28-11-1926.

L.140 Roadside near the S. part of portion 131v, parish of Bungeworgorai.
Collection.—L. C. Ball, 4-12-1926.

L.141 Portion 74v, parish of Bungeworgorai.
Collection.—L. C. Ball, 15-3-1930.

L.142 Minka.
Collection.—L. C. Ball, 1929.

L.143 Hickson's Orchard, Red Hill.
Collection.—L. C. Ball, 9-7-1927.

L.144 NE. part of portion 78v, parish of Euthulla.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.145 About 1 mile due S. of the SE. corner of portion 329, parish of Euthulla.
Collection.—Kalimna Oil Co., 1938–39.

L.146 About ½ mile E. of the NE. corner of portion 294v, parish of Euthulla.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.147 Mt. Bassett, at the S. part of portion 452, parish of Euthulla.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.148 NE. corner of portion 452, parish of Euthulla.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.149 NW. corner of portion 225, parish of Beaufort.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.150 Portion 223, parish of Beaufort.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.152 NW. corner of portion 179v, parish of Beaufort.
Collection.—J. E. Ridgway and B. Jones, 1929.

L.153 Sleepy Ck, 70 chains due N. of Blythdale. (Same locality as RD.128.)
Collection.—C. H. W. Thom, 1913.

L.154 SW. corner of portion 382v, parish of Wallumbilla, on Wallumbilla Ck. (Same locality as RD.207.)
Collection.—L. C. Ball.

L.269 Kangaroo Ck, at about the corner of portions 93 and 95, parish of Chadford.
Collection.—E. C. Saint-Smith and C. H. W. Thom, 1913.

L.270 Middle Ck, near the NE. corner of portion 479v, parish of Wallumbilla.
Collection.—E. C. Saint-Smith and C. H. W. Thom, 1913.

L.271 Middle Ck, near the NE. corner of portion 349v, parish of Wallumbilla. (Same locality as RD.205.)
Collection.—E. C. Saint-Smith and C. H. W. Thom, 1913.

L.272 Middle Ck, on portion 352v, parish of Wallumbilla.
Collection.—E. C. Saint-Smith and C. H. W. Thom, 1913.

AUTHOR'S COLLECTIONS

(Housed in Department of Geology and Mineralogy, University of Queensland, and Geological Survey of Queensland)
(Duplicate Collections)

RD. 6 E. bank of Bungil Ck at Minmi Crossing; Roma 4 mile military map reference 162706.

RD. 26 Gully just W. of of the Roma–Orallo road, in the NW. corner of portion 5v, parish of Euthulla; Roma 4 mile military map reference 153705.

RD. 39 Warooby Ck, 100 yards N. of where the Roma–Wallumbilla road crosses; Roma 4 mile military map reference 172697.

RD. 78 Small creek on the Roma–Orallo road, near the SW. corner of portion 25v, parish of Euthulla; Roma 4 mile military map reference 148708.

RD. 82 Roma–Orallo road just S. of where it crosses the Injune branch railway line near Minka; Roma 4 mile military map reference 152706.

RD. 94 Ridges just S. of Bungil Ck on portion 426, parish of Euthulla, about 600 yards upstream from Minmi Crossing; Roma 4 mile military map reference 161706.

RD. 95 Ridges on portion 428, parish of Euthulla; Roma 4 mile military map reference 161707.

RD. 97 Gully on E. side of Durham Downs road, 1 mile N. of where this road crosses Chinaman Creek; Roma 4 mile military map reference 162705.

RD. 98 Hillslope on the Durham Downs road, about 150 yards S. of Minmi crossing and just E. of Bungil Ck.

RD. 99 E. bank of a gully about ¼ mile NE. of Minmi crossing.

RD. 107 E. bank of Clerk Ck, 50 yards S. of where the road running N. from Hodgson crosses 2 miles N. of the old Hodgson township; Roma 4 mile military map reference 141703.

RD. 109 W. bank of Clerk Ck, 150 yards S. of where the road running N. from the old Hodgson township crosses; SW. corner of portion 3, parish of Hodgson. Roma 4 mile military map reference 141702.

RD. 119 E. bank of Mucaby Ck, just S. of where the Hodgson–Lenroy road crosses; Roma 4 mile military map reference 137704.

RD. 128 S. bank of Sleepy Ck, near the NW. corner of R.61, parish of Blythdale; Roma 4 mile military map reference 177699. (Same locality as L.153.)

RD. 205 Middle Ck, 50 yards S. of where the Wallumbilla–Taroom road crosses in the NE. corner of portion 349v, parish of Wallumbilla; Roma 4 mile military map reference 205706.

RD. 207 E. bank of Wallumbilla Ck at the SW. corner of portion 382v, parish of Wallumbilla; Roma 4 mile military map reference 196704. (Same locality as L.154.)

RD. 283 E. side of a gully at SW. end of the Grafton Range, in the SE. corner of portion 264, parish of Beaufort; Roma 4 mile military map reference 170713.

RD. 285 Gully just SE. of Blyth Ck, about ½ mile downstream from the junction of Blyth and Three Mile Creeks; Roma 4 mile military map reference, 181699.

RD. 301 Wallumbilla–Taroom road at its junction with the Raslie road; NE. corner of portion 369v, parish of Wallumbilla; Roma 4 mile military map reference 203704.

DEPARTMENT OF GEOLOGY AND MINERALOGY, UNIVERSITY OF QUEENSLAND COLLECTIONS

L. 318 Red Hill, Roma.
L. 319 Portion 88v, parish Euthulla.

L.2162 8 miles from Roma near Tineen, on either side of road.

PLATES 1–6

EXPLANATION OF PLATE 1

FIGS 1– 2. *Lingula* cf. *subovalis* Davidson. *Fig. 1.* F 7903 G.S.Q., exterior of an incomplete specimen showing ornament, x 3; locality RD.78. *Fig. 2.* F 35625 U.Q., an exfoliated specimen showing suboval shape, x 2; same locality.

FIGS 3– 4. *Neritopsis minmiensis* sp. nov. *Fig. 3.* F 7895 G.S.Q., oblique apical view of the paratype, x 1; locality L.143. *Fig. 4.* F 7896 G.S.Q., apertural view of the holotype, x 1; same locality.

FIGS 5– 6. *Acteon* ? *hochstetteri* Moore. *Fig. 5.* F 7846 G.S.Q., lateral view showing siphonal canal, x 4; locality L.149. *Fig. 6.* F 7847 G.S.Q., lateral view of a latex cast showing body whorl ornament, x 2·25; same locality.

FIGS 7– 9. *Euspira reflecta* (Moore). *Fig. 7.* F 35682 U.Q., apertural view of an internal mould; x 1; locality RD.78. *Fig. 8.* F 7890 G.S.Q., lateral view of an apically damaged specimen, showing body whorl ornament, x 1; locality L.143. *Fig. 9.* F 7891 G.S.Q., apertural view of an internal mould of a smaller specimen, x 1, same locality.

FIGS 10–14. *"Nuculana" minmiensis* sp. nov. *Fig. 10.* F 7845 G.S.Q., interior view of a latex cast of a left valve, paratype, x 1·25; locality L.272. *Fig. 11.* F 35512 U.Q., internal mould of a right valve showing buttressed anterior adductor scar, holotype, x 0·75; locality RD.99. *Fig. 12.* interior view of a latex cast of the holotype, x 1·2. *Fig. 13.* F 7844 G.S.Q., dorsal view of a latex cast of a left valve showing escutcheon and weak carina, paratype, x 2; locality L.272. *Fig. 14.* lateral view of exterior of the same latex cast, x 2.

FIGS 15–21. *Tancredia* (*Corburella*) *trigoniformis* sp. nov. *Fig. 15.* F 35562 U.Q., lateral view of the exterior of a latex cast of a right valve, paratype, x 1; locality RD.99. *Fig. 16* dorsal view of the same latex cast, x 0·75. *Fig. 17.* F 35578 U.Q., latex cast of the hinge area of a right valve, paratype, x 1; locality RD.128. *Fig. 18.* F 35576 U.Q., latex cast of the hinge area of a left valve, paratype, x 1; same locality. *Fig. 19.* F 35564 U.Q., interior view of a latex cast of a right valve, paratype, x 1; locality RD.99. *Fig. 20.* F 35581A U.Q., interior view of a latex cast of the left valve of the holotype, x 1; locality RD.128. *Fig. 21* F 35581B U.Q., interior view of a latex cast of the right valve of the holotype, x 1.

FIGS 22–23. ? *Peratobelus australis* (Phillips). *Fig. 22.* F 35511 U.Q., left lateral view of a guard showing dorso-, medio-, and ventral-lateral grooves, x 1; locality RD.99. *Fig. 23.* F 35606 U.Q., right lateral view of a guard with the alveolar region preserved, x 1; same locality.

FIGS 24–26. *Tatella maranoana* (Etheridge Jnr.). *Fig. 24.* F 35608 U.Q., interior view of a latex cast of a right valve, x 1; locality RD.99. *Fig. 25.* F 35571 U.Q., interior view of a latex cast of a left valve, x 1; locality RD.128. *Fig. 26.* F 35607 U.Q., exterior view of a latex cast of a right valve, x 1; locality RD.99.

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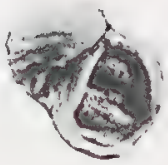
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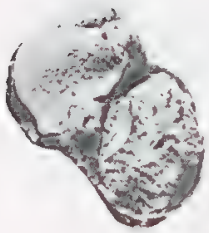
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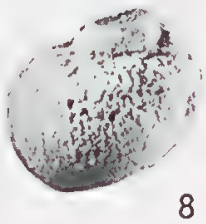
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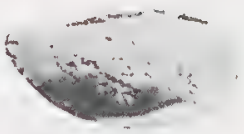
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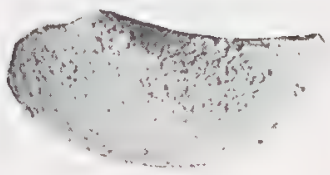
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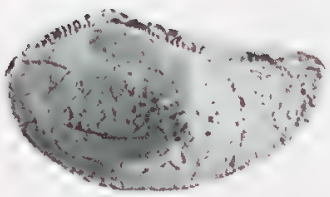
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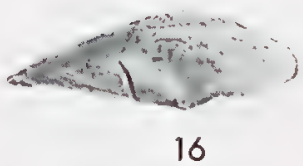
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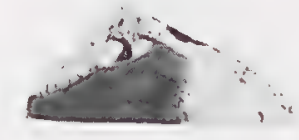
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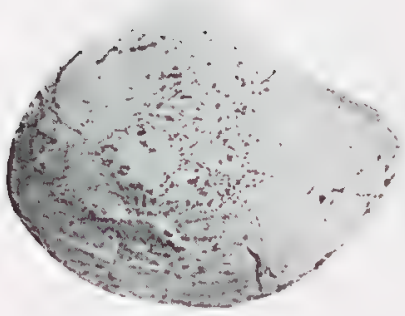
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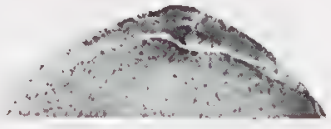
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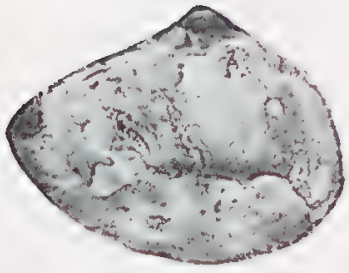
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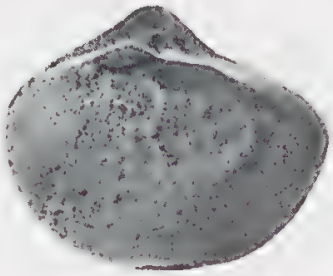
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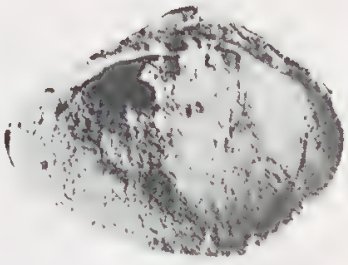
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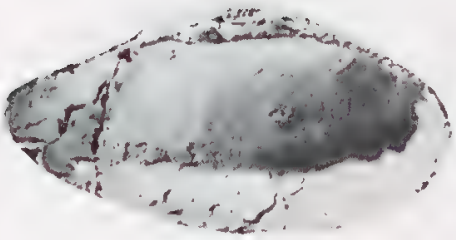
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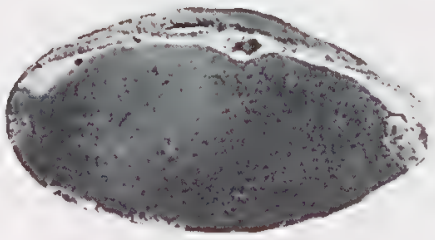
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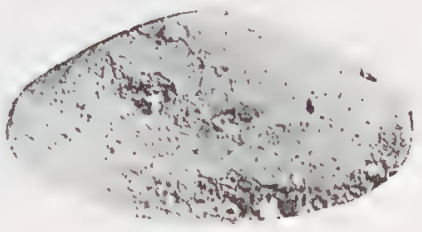
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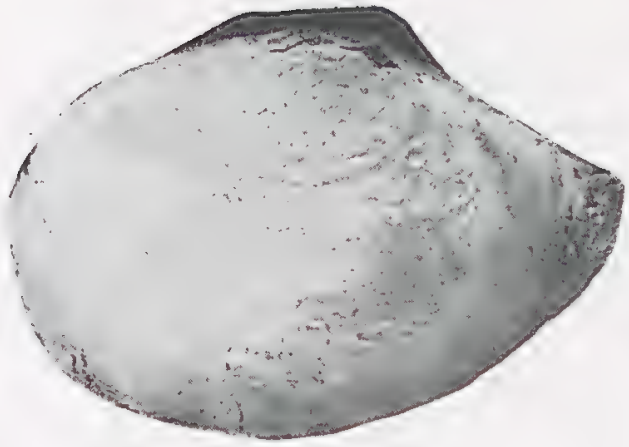
PLATE 1

EXPLANATION OF PLATE 2

FIGS 1– 4. *Tancretella plana* (Moore). *Fig. 1.* F 7897 G.S.Q., latex cast of an internal mould of a left valve showing cardinal tooth and buttressed anterior adductor scar, x 0·94; locality RD.283. *Fig. 2.* dorsal view of a latex cast of the external mould of the same specimen, x 0·7. *Fig. 3.* lateral view of the same latex cast, x 1. *Fig. 4.* F 1332 G.S.Q., internal mould of the left valve figured by Etheridge Jnr. (1892, pl. 27, fig. 8), x 1; locality "Minmi near Roma".

FIGS 5– 6. *Fissilunula clarkei* (Moore). *Fig. 5.* F 7898 G.S.Q., latex cast of an internal mould of a left valve showing dentition, x 1 (same specimen as text-fig. 3a); locality RD.207. *Fig. 6.* F 7899 G.S.Q., latex cast of an internal mould of right valve showing dentition, x 0·9 (same specimen as text-fig. 3b); same locality.

FIGS 7– 9. *Periplomya* cf. *robinaldina* (d'Orbigny). *Fig. 7.* F 9182 G.S.Q., exterior view of a left valve showing anterior carina, x 1; locality L.150. *Fig. 8.* F 30491 U.Q., internal mould of a right valve, x 0·8; locality L.2162. *Fig. 9.* F 30490 U.Q., internal mould of a left valve showing the laminar anterior tooth as a groove, x 1; same locality.



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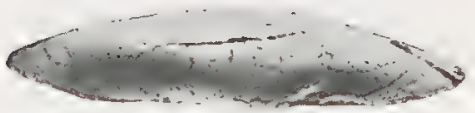

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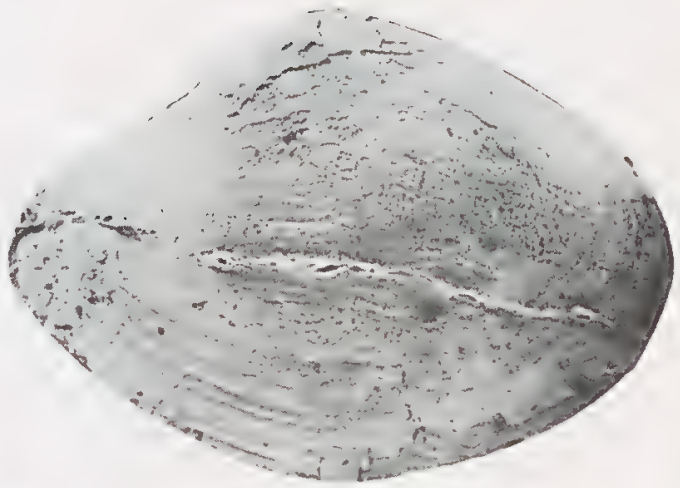

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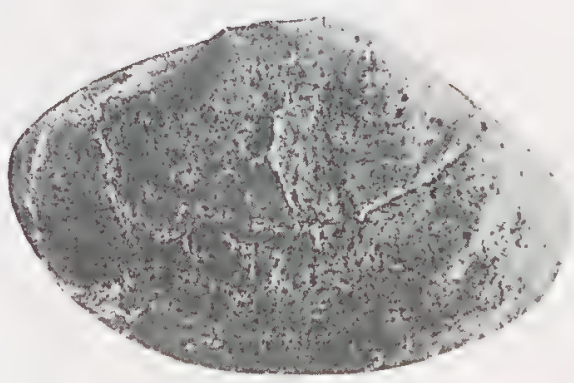

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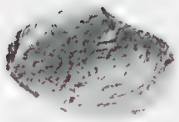

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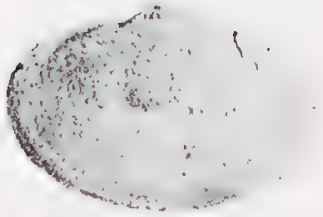

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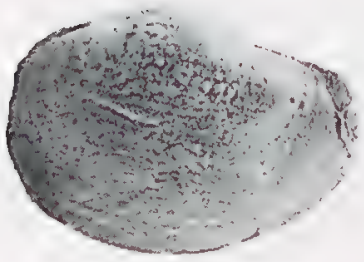

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PLATE 2

EXPLANATION OF PLATE 3

FIGS 1– 3. *Eyrena tatei* (Etheridge Jnr.). *Fig. 1.* F 35560 U.Q., dorsal view of an internal mould of closed valves showing moderate inflation, x 1·5; locality RD.6. *Fig. 2.* F 30723 U.Q., exfoliated right valve showing carina, x 1; locality L.318. *Fig. 3.* F 35560 U.Q., latex cast of the external mould of the right valve of the specimen of fig. 1, x 1.

FIGS 4– 6. *Inoperna ensiformis* (Etheridge Jnr.). *Fig. 4.* F 35759 U.Q., left valve exterior showing plicate dorsal ornament, x 2·3; locality L.2162. *Fig. 5.* F 30727 U.Q., posterior portion of an incomplete left valve, x 1; locality L.318. *Fig. 6.* F 30724 U.Q., anterior portion of an incomplete right valve showing carina, x 1; same locality.

FIGS 7– 8. *Cyrenopsis* cf. *meeki* (Etheridge Jnr.). *Fig. 7.* F 7893 G.S.Q., exterior of a right valve, x 0·75; locality L.143. *Fig. 8.* dorsal view of the same specimen, x 1.

FIGS 9–14. *Cyrenopsis balli* sp. nov. *Fig. 9.* F 9164 G.S.Q., dorsal view of a left valve, paratype, x 0·9; locality L.143. *Fig. 10.* F 9160 G.S.Q., latex cast of an internal mould of a right valve, paratype, x 1; locality "Damper Gully, 1 mile W. of Midcontinental oil well". *Fig. 11.* exterior lateral view of the specimen of fig. 9, x 0·9. *Fig. 12.* F 9171 G.S.Q., dorsal view of an internal mould of closed valves showing well impressed adductor scars, paratype, x 1; locality L.143. *Fig. 13.* F 9161 G.S.Q., latex cast of an internal mould of a right valve, holotype, x 1; same locality as F 9160. *Fig. 14.* same cast, x 3 (also figured as text-fig. 4).

FIGS 15–19. *Maranoana etheridgei* gen. and sp. nov. *Fig. 15.* F 28842 U.Q., exterior view of a left valve, x 0·9; locality L.319. *Fig. 16.* F 7861B G.S.Q., latex cast of a damaged external mould of a left valve, x 0·9; locality "Burns well (60 ft ?) por. 90 Kangaroo Ck". *Fig. 17.* F 7861A G.S.Q., latex cast of an internal mould of a left valve showing small cardinal tooth, x 0·9; same locality. *Fig. 18.* F 35570 U.Q., dorsal view of an internal mould of closed valves showing anterior and posterior gape, x 0·9; locality RD.128. *Fig. 19.* F 35572 U.Q., latex cast of an internal mould of an anteriorly damaged right valve, x 0·9; same locality.

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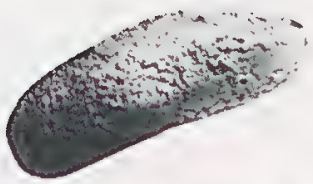

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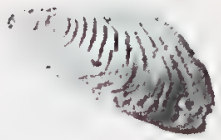

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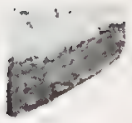

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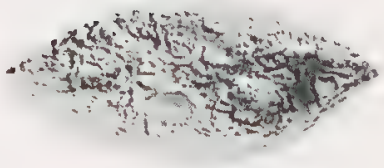

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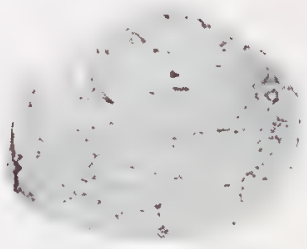

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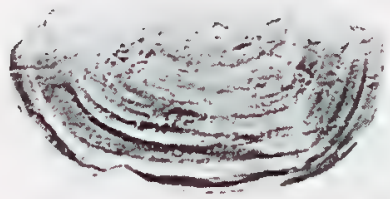

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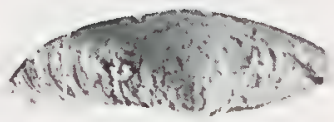

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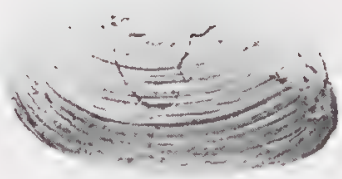

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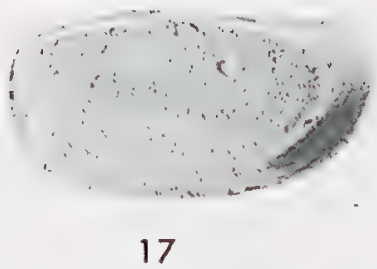

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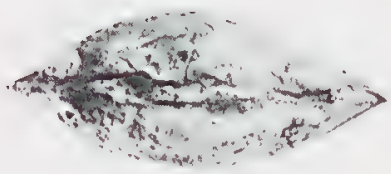

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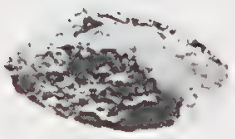

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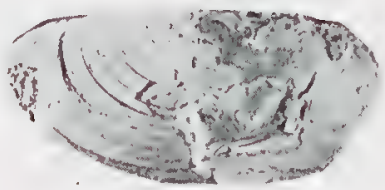

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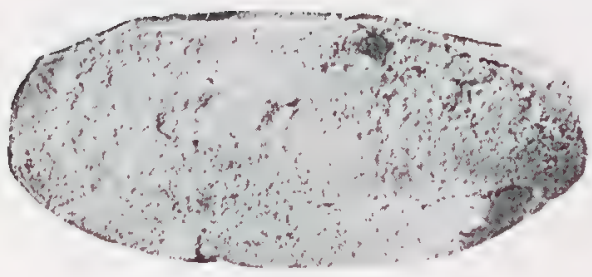

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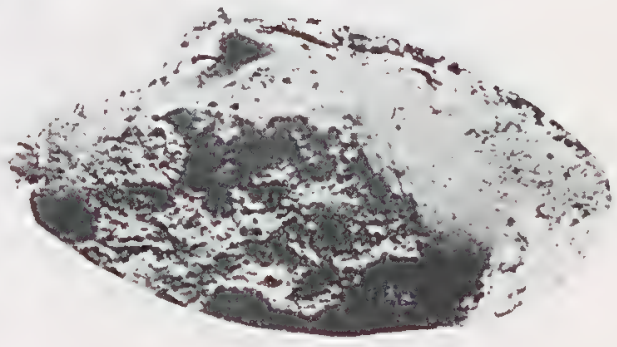

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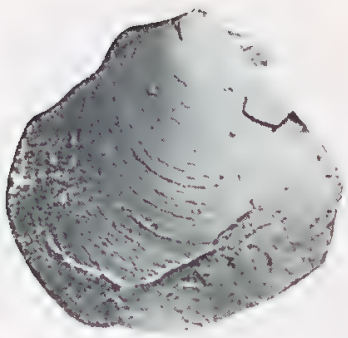
PLATE 3

EXPLANATION OF PLATE 4

FIGS 1– 3. *Camptonectes socialis* (Moore). *Fig. 1.* F 9185 G.S.Q., exterior lateral view of a partially exfoliated right valve with damaged auricles, x 0·9; locality L.143. *Fig. 2.* F 30505 U.Q., exterior lateral view of a ventrally incomplete right valve showing auricles, x 1; locality L.319. *Fig. 3.* dorsal view of specimen of fig. 1 showing inequality of valves, x 1.

FIGS 4– 5. *Thracia primula* Hudleston. *Fig. 4.* F 7841 G.S.Q., latex cast showing the left valve fitting inside the right, the opisthodetic external ligament and posterior carina, x 1; locality "Clerk Ck 1½ miles below junction with Bindango Ck". *Fig. 5.* F 1341 G.S.Q., internal mould of a left valve figured by Etheridge Jnr. (1892, pl. 28, fig. 11), x 1; locality "Minmi near Roma".

FIGS 6–13. *Eyrena linguloides* (Hudleston). *Fig. 6.* F 35539 U.Q., latex cast of an external mould of a small left valve showing prominent growth ridges, x 1; locality RD.107. *Fig. 7.* F 7863 G.S.Q., dorsal view of closed valves showing ligament gape, x 1; locality L.142. *Fig. 8.* exterior lateral view of the right valve of the same specimen, x 1. *Fig. 9.* anterior view of the same specimen showing inrolled beaks, x 1·14. *Fig. 10.* F 7909 G.S.Q., latex cast of an internal mould of a posteriorly incomplete left valve showing the sub-umbonal denticle, thickened ligament area, and laminar posterior tooth, x 1; locality L.145. *Fig. 11.* F 7906 G.S.Q., latex cast of an internal mould of a posteriorly incomplete right valve, x 1; same locality. *Fig. 12.* F 7097 G.S.Q., latex cast of an internal mould of a right valve showing two sub-umbonal denticles, thickened ligament area and laminar posterior tooth, x 0·9; same locality. *Fig. 13* same latex cast, x 1·8.



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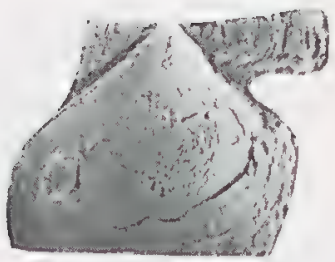

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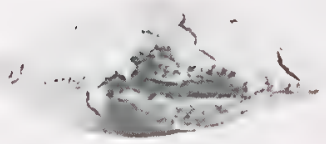

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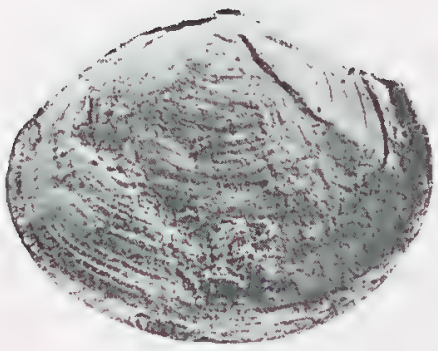

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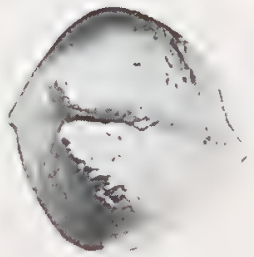

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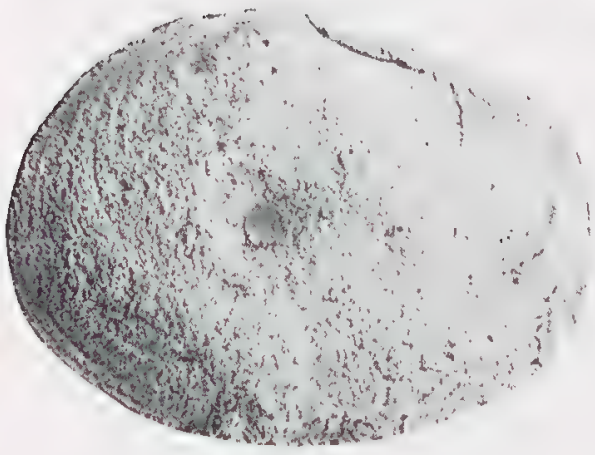

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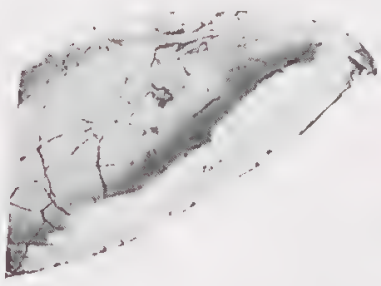

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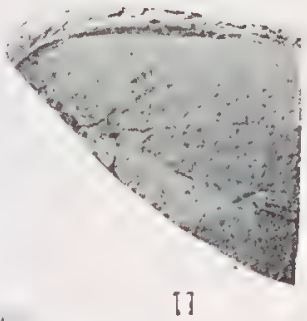

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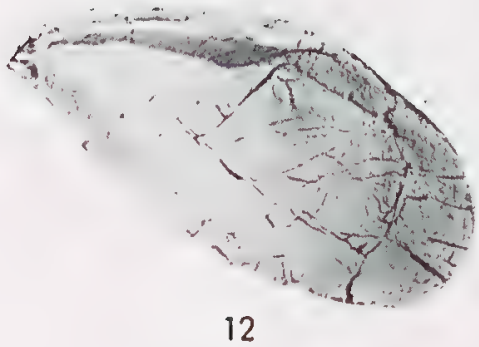

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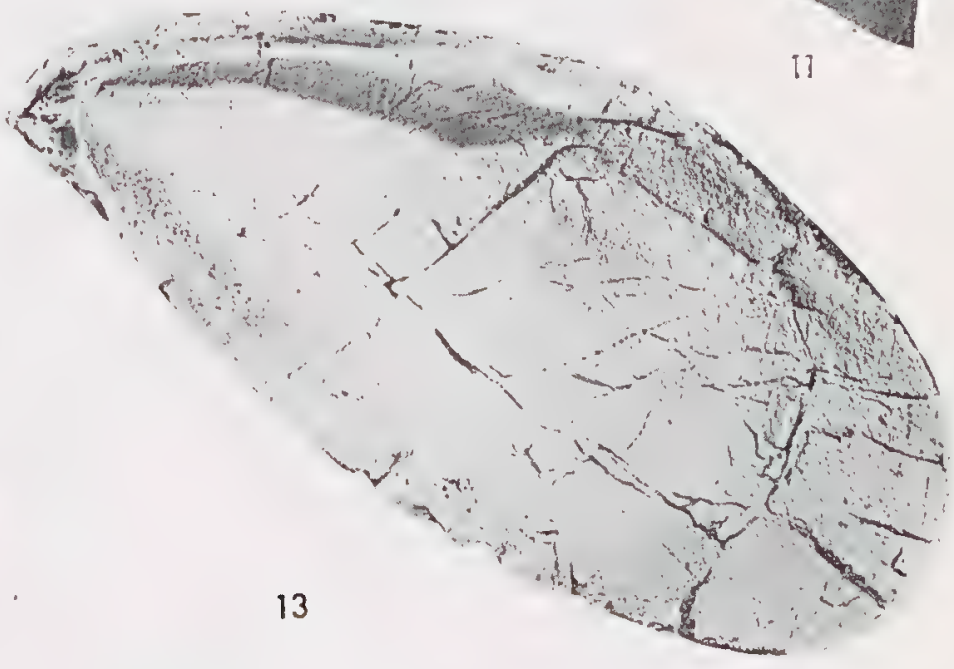

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PLATE 4

EXPLANATION OF PLATE 5

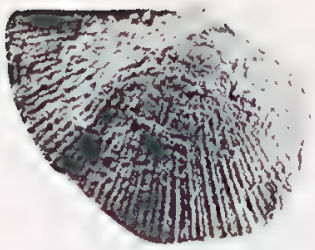
FIGS 1– 3. *Maccoyella subangularis* Etheridge Jnr. *Fig. 1.* F 7843 G.S.Q., right valve showing extended posterior wing, x 1·2; locality L.153. *Fig. 2.* F 35536 U.Q., latex cast of an external mould of a left valve, x 0·85; locality RD.26. *Fig. 3.* F 35774 U.Q., hinge of a left valve showing sub-umbonal tooth, and narrow ligament area bounded anteriorly by a transverse ridge, x 2; locality, L. 318.

FIG 4. *Pseudavicula anomala* (Moore). *Fig. 4.* F 9176 G.S.Q., exfoliated right valve, x 1·9; locality L.144.

FIGS 5–15. *Meleagrinella woodsi* sp. nov. *Fig. 5.* F 35510 U.Q., interior view of a left valve, holotype, x 0·8; locality RD.99. *Fig. 6.* hinge area of the same specimen showing narrow ligament area bounded anteriorly by a transverse ridge, and small subumbonal tooth-like swelling, x 2·5. *Fig. 7.* F 7910 G.S.Q., dorsal view of a left valve, paratype, x 1; locality L.153. *Fig. 8.* dorsal view of the holotype showing crenulate anterior ear, x 0·9. *Fig. 9.* exterior lateral view of the specimen of fig. 7, x 1. *Fig. 10.* exterior lateral view of the holotype, x 6. *Fig. 11.* F 28848 U.Q., exfoliated right valve showing anterior ear and postero-ventral sulcus, paratype, x 1; locality L.318. *Fig. 12.* F 7913 G.S.Q., left valve showing well preserved ornament, paratype, x 1; locality L.153. *Fig. 13* F 35666 U.Q., dorsal view of a right valve showing anterior ear and subauricular notch, paratype, x 1; locality RD.99. *Fig. 14,* exterior lateral view of the same specimen, x 1·2. *Fig. 15.* F 35623 U.Q., exfoliated left valve showing postero-ventral sulcus, paratype, x 1; locality L.2162.

FIGS 16–17. *Meleagrinella* sp. *Fig. 16.* F 7842 G.S.Q., exfoliated left valve, x 1; locality L.134. *Fig. 17.* the same specimen showing ornament, x 2·3.

FIGS 18–19. *Maccoyella barklyi* (Moore). *Fig. 18.* F 35737B U.Q., latex cast of an internal mould of a left valve showing wide ligament area bounded anteriorly by a transverse ridge, and strong sub-umbonal tooth flanked by sockets, x 1; locality RD.107. *Fig. 19.* F 9189 G.S.Q., exfoliated right valve, x 0·85; locality "Murray's well, por. 115v, par. Bungeworgorai".



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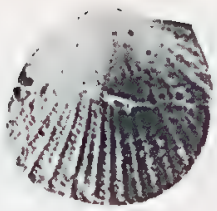

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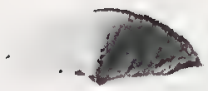

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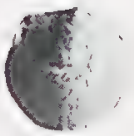

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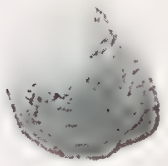

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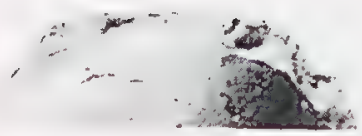

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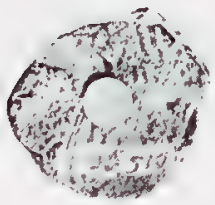

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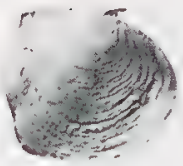

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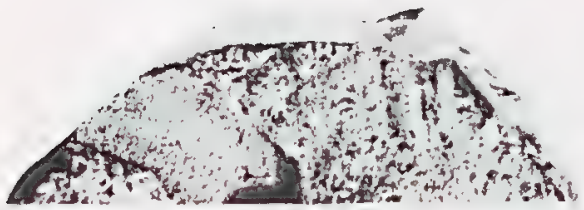

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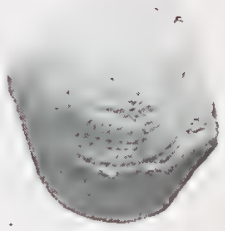

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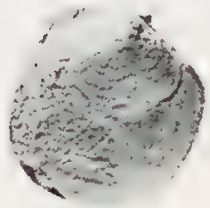

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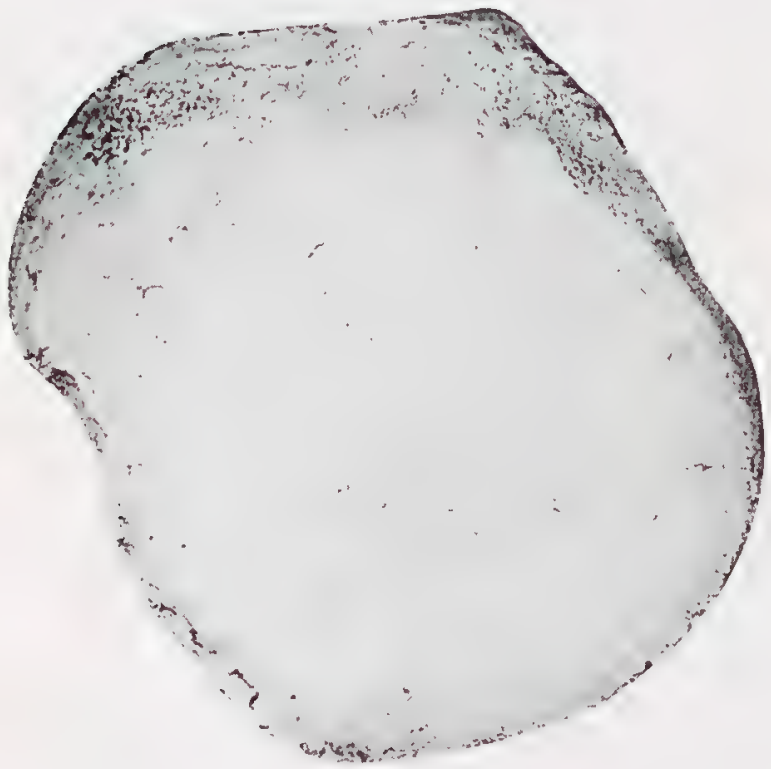

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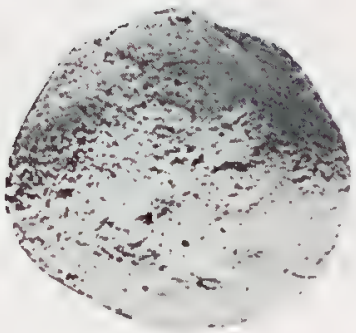

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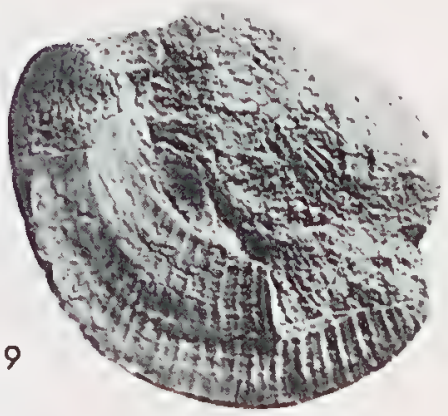

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PLATE 5

EXPLANATION OF PLATE 6

FIGS 1– 3. *Panopea maccoyi* (Moore). *Fig. 1.* F 1329 G.S.Q., internal mould of a right valve figured by Etheridge Jnr. (1892, pl. 28, fig. 6), x 0·8; locality "Minmi near Roma". *Fig. 2.* F 9175 G.S.Q., dorsal view of an internal mould of closed valves showing posterior gape, x 1; locality "Clerk Ck 1 mile below junction of Bindango Ck". *Fig. 3.* F 35514 U.Q., internal mould of a left valve, x 1; locality RD.107.

FIGS 4– 7. *Maccoyella barklyi* (Moore). *Fig. 4.* F 9188 G.S.Q., exfoliated left valve of a posteriorly incomplete specimen showing adductor muscle scar and pitted pallial line impressed on the internal mould, x 1; locality "Murray's well, por. 115v, par. Bungeworgorai". *Fig. 5.* dorsal view of the closed valves of the same specimen with shell of the left valve removed, x 1. *Fig. 6.* the same showing inequality of the valves, and articulation of the sub-umbonal tooth with the socketed anterior ear of the right valve, x 2. *Fig. 7.* F 35737A U.Q., latex cast of an external mould of a left valve showing primary, secondary and tertiary radial ribs, and postero-ventral sulcus, x 1; locality RD.107.

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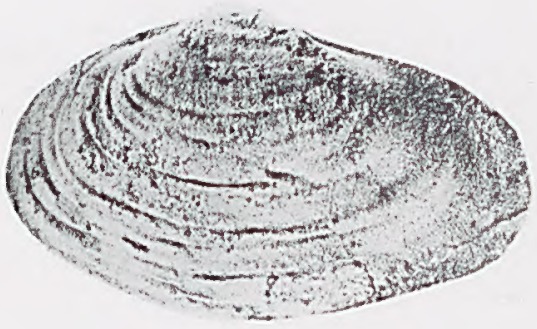

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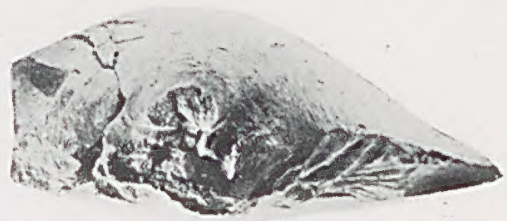

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PLATE 6

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